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**MICRO-MACRO ECONOMIC ANALYSIS OF  
'KHAT' PRODUCTION IN ETHIOPIA**

BY

MICHAEL ARREFAINE

A THESIS SUBMITTED TO THE SCHOOL OF  
GRADUATE STUDIES OF THE ADDIS ABABA UNIVERSITY  
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
OF THE DEGREE OF MASTER OF SCIENCE  
IN ECONOMICS (INTERNATIONAL ECONOMICS)

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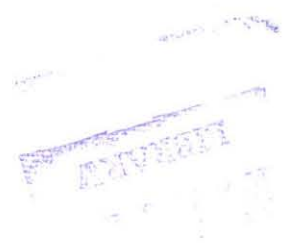
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Production in Ethiopia**

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*Dedicated to*

*My late father, Arrefaine Abadi*



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## ABSTRACT

Most studies on the plant khat (*catha edulis*)-*the mild stimulant cash crop*- focus on description of the social behavior, health implications and psychological effects on consumers. Due to this most policy actions taken in this regard are one sided since they neglect the economic contribution of khat. The present study tried to describe the economic role of khat in Ethiopia. Graphs and tables are used for this purpose. Results indicate that khat is clearly an important cash crop i.e. as a source of foreign exchange, source of tax revenue to the government and creating employment opportunity both to the farmers and urban dwellers. Thus, it is recommended that policy makers should take into consideration the economic role of khat to understand the impact of alternative policy packages and/or external shocks that may have an effect on income/employment of individual khat producers and on the whole economy.

The study also assesses the supply elasticity of khat with respect to its own price and price of food crops (teff, wheat & maize) and coffee, so as to examine its relationship with food crops and coffee. Besides labor and fertilizer, non- price factors such as land and animal power are also included as explanatory variables. The methodology applied, which is firmly rooted in neo-classical theory, deals with the estimation of *profit (dual of the production function)*, *supply* and input demand functions; the parameters are mainly based on cross-farm variation. A cross-section secondary data from the 5<sup>th</sup> round of the Ethiopian Rural household Survey held in 1999 is used to present empirical estimates.

Estimated results indicate that own price supply elasticity of outputs is very low and output supply is not responsive to price of fertilizers and wage rate. Particularly, supply of khat is found to be non-responsive to its own-price. On the other hand, the supply of khat is more responsive to the decline in the price of food crops. Finally, results indicate that non-price factors are far more important in affecting production.

Thus, it is recommended that in order to induce farmers to produce more of food crops (and less of khat) price policies alone could not bring the desired outcome. Rather, price policies should be accompanied by non-price policies.

## **Chapter I - INTRODUCTION**

### **1.1 Overview**

The role of khat- the mild stimulant cash crop- in the Ethiopian economy is increasing from time to time both at macro and micro level -i.e. as a source of income to the individual producers, government tax revenue, source of foreign exchange and employment to the economy at large. On the other hand, the increase in the production of khat have challenged the development of the agricultural sector since farmers are shifting away from producing other food crops (and coffee) - leaving the government's objective of attaining self sufficiency in food production in danger.

However, there are no detailed quantitative economic analyses so far that examine these two fundamental issues.

Thus, the current study aims at identifying and estimating the factors that affects the supply of khat and its role in the macro-economic activities of Ethiopia. Such analysis is central to policy makers in that it helps understand the impact of alternative policy packages or external shocks (for instance, recently some regional states are legally prohibiting the consumption of khat), that may have on the individual khat producers and on the economy at large (i.e. on external trade, employment and government revenue).

The analysis will include specifying an econometric model of supply function of khat so as to estimate its own-price elasticity; its relationship with the production decision of other

food and cash crops, such as estimating its cross-price elasticities. A multiple regression analysis is used to present empirical estimates of the parameters.

The methodology applied, which is firmly rooted in neo-classical theory, deals with the estimation of *profit (dual of the production function)*, *supply* and input demand functions; the parameters are mainly based on cross-farm variation. A cross-section secondary data from the 5<sup>th</sup> round of the Ethiopian Rural household Survey held in 1999 is used to present empirical estimates.

The own-price elasticity of khat is expected to be positive consistent with the usual view that the supply of cash crops is responsive to price changes. Besides price, other factors such as fertilizer use are expected to significantly affect the supply of *khat*. The cross-price elasticity of khat is expected to be negative – indicating that farmers who at one time producing other food crops are shifting to the production of khat.

Moreover, the role of khat as a source of foreign exchange, employment and government tax revenue both at federal and regional level is expected to be growing from time to time and a descriptive statistical technique is used to examine these relationships. For this purpose secondary data collected from various bulletins of the National Bank of Ethiopia, Central Statistics Office and Ministry of Finance and Economic Development is used. Some khat sellers and consumers were also informally interviewed to gather primary data.

## 1.2 Statement of Problem and Justification:

The role of khat in the Ethiopian economy has been growing from time to time both at macro and micro levels. The economic role of khat at macro level have been increasing when one examines its contribution to the foreign exchange supply of the country, government tax revenue and employment opportunity. For instance, the export share of khat was about 16%,20%,19%,18%,21% and 25% in 1998/99, 1999/00,2000/01,2001/02,2002/03 and 2003/04 respectively, next to Coffee -which its share was 75%, 70%,57%,60%,60% and 63% respectively for similar periods (NBE, Annual Report, 2003/04).

On the other hand, however, it is argued that despite its positive role in contributing to the Ethiopian economy, the increasing tendency of farmers towards production of khat *and* away from other food and cash crops could harm the agricultural sector of the country at aggregate level (since the supply of food crops would reduce) and hence leaving the objective of attaining self-sufficiency in food production in danger –which is the ‘primary concern’ of the government. This can be easily seen from the fact that production of khat, which was only concentrated in some parts of the country , now has expanded to most regions in Ethiopia, which ones known as high food crops growing areas (Luelseged and Dercon,1994; and see Figure 2).

The issues rose above requires an empirical investigations and evidences. This is, therefore, the *main aim* of this study; i.e. to show the extent to which farmers are reallocating their scarce resource away from food crops in to the production of khat. This is

done by estimating and identifying *the* factors that affect the supply response of khat, estimating the cross-price elasticity of khat supply and quantifying the economic role of khat in the Ethiopian economy.

### **1.3 Research Objectives:**

The objectives of this study are: -

1. To specify the supply function of khat so as to empirically estimate the factors (both economic and non-economic) that affect the decision of khat producers; measuring its own-price supply elasticity; estimating its cross-price elasticities so as to examine its relationship with other food crops and coffee.
2. Analyzing the role of khat on the Ethiopian economy, i.e. as a source of foreign exchange supply, tax revenue and employment, by providing empirical evidence.

### **1.4 Research Questions and Hypothesis:**

While the general objective of this study is to analyze the response of khat producers to various variables, both economic and non-economic, by providing empirical evidence and analyzing the role of khat in the Ethiopian economy, there are several other questions to be answered within this context.

Among these are: first, why are farmers shifting away from producing other food crops and reallocating their scarce resources to the production of cash crops, particularly to khat, even though there is “shortage” of supply of food crops in the market; second, what are the

contributions of khat production to the Ethiopian economy at large, i.e. in terms of employment, external trade, and government fiscal revenues; finally, what are the potential impacts of the increasing tendency of some of regional states in prohibiting the consumption of khat on the income receipts of farmers , employment , foreign exchange supply and tax revenue.

**The hypotheses of this study are:**

1. Own-price elasticity of khat is positive; supply elasticity of khat with respect to price of inputs (labor and fertilizer use) and non-price factors (land) is negative and positive respectively.
2. The cross-price elasticity of khat with respect to other food crops and coffee is negative- indicating substitutability between khat production and other food crops.
3. The contribution of khat production to tax income, employment and foreign exchange earning is *significant*.

**1.5 Significance of the Study**

Most studies on the agricultural sector of Ethiopia are concerned or focus at the contribution of the agricultural sector to the development of the country in general and its performance in particular.

Although such studies are important on their own right they fail to take into account the specific effect of individual crops in the development of the country in general and at farmers' level in particular.

Furthermore, the rationale for the study of supply response of individual crops is due to the fact that supply elasticity for specific crops and the agricultural sector as whole have been found quite different in several studies, (see, for instance, Sadoulet and de Janvry, 1995). Thus, in studying the elasticity of supply response in agriculture, a critical distinction must be made between the response of an individual crop and that of broad agricultural aggregates.

Alemayehu (2002) also noted that studies that assess the export performance of sub-Saharan African countries calls for a disaggregate estimation of export supply functions in order to shed light on factors influencing each category of export volumes.

Thus, the current study is believed to address these by specifying and estimating supply function for khat unlike the previous studies that focus on specifying and estimating a supply function for aggregate agricultural products. Moreover, most of the peasants supply response studies in Ethiopia adopt the ad hoc specifications of supply response functions and carried estimations using time series data. This approach often lacks a sound theoretical basis. In contrast, the current study is based on the profit function analysis (dual of the production function), an approach firmly rooted in neoclassical production theory, to derive the system of output supply and input demand.

Finally, most studies on the plant khat (both at national and international level) so far focus on descriptions of the social behavior of consumers, health implications and the effects on young consumers. Due to this most policy actions taken in this regard are one sided since they neglect the economic contribution of khat production. Thus we believe the results obtained from the current study will help policy makers (both at Federal and Regional levels) to understand the impact of alternative policy packages and/or external shocks that may have an effect on income/employment of individual khat producers and on the whole economy.

#### **1.6. Data**

To investigate the supply response of khat, a household data gathered during the 5<sup>th</sup> round of the Ethiopian Rural Household Survey conducted in 1999 by the department of Economics and Institute of Development Research of Addis Ababa University and Center for the Study of African economies, Oxford University is used.

In studying the role of khat in the Ethiopia economy, secondary data collected from various reports of the National Bank of Ethiopia, Ethiopian Ministry of Finance and Economic Development, Central Statistical Authority Agricultural Surveys and Ethiopian Rural Household Survey conducted in 1999 are used. Moreover, primary data collected by informal interview is used.

### **1.7. Limitation of the study**

One of the major problems encountered in this study is lack of data, covering a long period of time, in examining the economic contribution of khat to the Ethiopian economy. In the past years trade statistics on khat was repressed, since it was considered as a drug. Particularly, data on the number of labor employed in the khat sector could not be found. Moreover, data for tax revenue from khat production and /or selling at national level could not be found. This is partly, because, tax revenue from khat is collected by the regional states and we found it difficult to find a complete set of data from one source. Thus, lack of relevant data imposed some limitations on the empirical evidences presented in chapter III.

A second point of limitation is related to modeling of some important variables. Particularly, our equations presented in chapter IV are controlled for short-term influencing factors (labor & fertilizer-use) and fixed factors (land and animal power). However, several *important* variables are missing. For instance, a rainfall variable, which is one of the major factors, affecting the Ethiopian agricultural production is lacking in the data set used for our model. This implies that estimated coefficients will be biased to the extent that missing explanatory variables.

The study also suffers considerably from ignoring the so-called structural variables (such as transport and communication means). Structural factors can be highly correlated with price and production variables used in the model. In that case, it becomes hard to disentangle the pure price effect from structural factors. Another problem, particularly

khat is a perennial crop the most substantial production effect following a price increase is expected to take place only after a few years, when newly planted trees become productive.

Finally, neoclassical theory should be used carefully for modeling production behavior in low-income countries, such as Ethiopia, where imperfections in markets that the producers face are widespread. Thus, all the resulting elasticities should be interpreted by taking these shortcomings and limitations into considerations.

### **1.8 Organization of the study**

The rest of the paper is organized as follows. Chapter II reviews the literature by focusing on the alternative approaches to the measurement of supply response and estimation techniques. In chapter III, we will describe the plant khat and its economic contribution in Ethiopia. Chapter IV discusses the methodology used in arriving systems of outputs and input demand, data used, estimation results and policy implications. Summary and conclusions is presented in chapter V.

## **Chapter II- Theoretical Literature Review**

### **Introduction**

Agricultural supply theory provides a basis for predictions concerning the way farmers (peasants) vary their output supply and demand for inputs in response to changes in prices and non-price factors. Moreover, assisting policy debate requires more than the qualitative insights given by theory. Particularly, it requires quantification of the various mechanisms analyzed by theory, such as measuring elasticities (Walter et al, 1998; Sadoulet and de Janvry, 1995).

A number of alternative approaches to estimation of elasticities of supply response are available both in structural and reduced form (Abebe, 1998; Alemayehu, 2002). In section 2.1 we will briefly review these approaches and estimation techniques. Definition of concepts /terms related to the study of supply response will be presented in section 2.2. In section 2.3 we will review some empirical research in some developing countries and in Ethiopia.

## 2.1. Alternative approaches to the measurement of supply Response

### 2.1.1. Structural Form Approaches: Estimation of the structure and derivation of the supply response.

These approaches concerns estimation of the structure of production functions and derivation of the supply response from it with the help of such analytical tools, such as: *production function estimation, profit function approach or cost function approach, linear programming and complete structural models.*

*Production function estimation* uses farm surveys or time series data on output, variable and fixed factors from which a production function can be estimated. Using the first-order conditions for profit maximization the supply responses can then be estimated (Abrar, 2001; Sadoulet and de Janvry, 1995). The parameters of the derived systems of equations should be estimated taking account of the cross-equation restrictions (Green, 2000; Varian, 1992).

In the *profit function approach* the term *primal* has been used to refer to an optimization problem consisting of a behavioral assumption (e.g. maximize profit) and a set of constraints (e.g. the production function). The maximization problem can be expressed as follows (Varian, 1992):

$$\text{Max}_{x,q} p'q - w'x, \text{ s.t } h(q, x, z) = 0$$

Where  $w$  and  $p$  are the prices of inputs and outputs,  $p'q - w'x$  is the producer's restricted profit ("restricted" profits means that only variable costs are subtracted from gross revenues).

The profit function can be estimated from a combination of cross-sectional and/or time series data that shows farmers profits, exogenous variables, prices and fixed factors. Assuming a differentiable form of the specification, the solution to this maximization problem is a set of input demand and output supply functions that can in principle be derived by solving the first order condition (Shumway, 1995). The derived input demand and output supply functions are:

$$x = x(p, w, z) \text{ and } q = q(p, w, z).$$

Substituting these expressions into the definition of profit gives the *profit function*,  $\pi$ , which is the maximum profit that the farmer could obtain given the prices, the availability of fixed factors and the production technology:

$$\pi(p, w, z).$$

The *cost function approach* is similar to the *profit function approach*. Starting again from the production function the producer is assumed to *minimize* costs to produce a given level of output. The minimization problem can be expressed as follows (Kreps, 1990).

$$\text{Min}_x w'x \quad \text{s.t } h(q, x, z) = 0.$$

The solution to this minimization problem is a set of input demands:

$$x = x(p, w, z),$$

and the cost function is the corresponding minimum variable cost of producing the given output,  $c(w, z, q)$ .

*Linear programming* is basically the same approach as above except that the production function is specified as a set of fixed coefficients and the profit maximization problem includes a set of effective constraints. Supply response is derived by parametric programming, solving for optimal quantities as prices vary (Sadoulet and de Janvry, 1995).

Finally, *complete structural models* of the farm sector or of the whole economy can also be estimated and the supply function derived by simulation. Such models include multi-market and general equilibrium models (Sadoulet and de Janvry, 1995).

### **2.1.2. Reduced Form Approaches: Derived estimation of the supply response.**

This approach includes: a) estimation of complete systems of output supply and input demand deriving from a profit function or cost function; b) a direct estimation of supply response of which the ad hoc specifications of supply response including partial adjustment and expectations formation is an integral part and; c) estimation of Structural models of supply and demand equilibrium (for instance, cobweb models) (Abebe, 1998; Alemayehu, 2002).

a) In deriving the complete systems of output supply and input demand from a profit function approach; it is assumed that profit –maximizing behavior can be described by a *profit function*, the so-called *dual* of the production function (Walter et al, 1998; Varian, 1992). In this (*dual*) approach, the production technology is not estimated directly (Abrar, 2001). Instead, profit function is used to study the production behavior of firms, since it is possible to recover all economically relevant information about the technology.

The *Profit function* is a function of exogenously determined output and input prices and fixed production factors, describing the farm's production technology at profit-maximizing points in the set of production possibilities.

In sum, assuming that farmers choose combinations of the variable inputs and outputs that will maximize profit, Lau (1976) has shown that the *restricted* profit function defined as the excess of total value of output over the costs of variable inputs, can be expressed as: (Abrar, 2001; Walter et al, 1998)

$$\Pi(p, c) = \text{Max}_q (p \cdot q / q \in T(c), c \in C) \dots\dots\dots (2.1)$$

where  $q$  is a vector of outputs ( $q_i > 0$ ) and inputs ( $q_i < 0$ ),  $p$  is a vector of output and input prices,  $c$  is a fixed or environmental factors (such as fixed land endowment, weather and government policies, captured by  $C$ ) and  $T$  summarizes the state of the technology constrained by  $c$ .

For the profit function to represent consistent profit-optimising behaviour, however, it should satisfy some theoretical restrictions (Varian, 1992). First, it should be *homogeneous of degree one* in prices. This implies that scaling all prices by a positive factor  $t$  won't change the optimal choice of the firm, and therefore profits will scale by the same factor. If profits do not scale up proportionally and there were no apparent changes in the environment, we might suspect that the firm in question is not maximizing profits (Kreps, 1990).

Second, the profit function should be increasing in output prices, decreasing in input prices. Suppose output price increased and input price (cost) decreased; if we observe that

the profit of the firm in question did not increase we may conclude that the firm in question is not maximizing profit in the first place (Nicholson, 1992).

The profit function in (2.1.) has two interesting properties: its first derivative with respect to the price of a product is equal to the supply function of that product; and its derivative with respect to the price of an input is equal to the demand function of that input. This relationship called the Hotelling lemma (or the derivative property) is used to derive the output supply and input demand functions as follows (Walter et al, 1998):

$$\frac{\partial \Pi}{\partial p_i} = q_i \quad \text{and} \quad \frac{\partial \Pi}{\partial p_k} = -q_k \dots\dots\dots (2.2)$$

Where  $i$  and  $k$  represent output and input respectively.

*The minus sign ( $-q_k$ ) comes from the fact that we are increasing the price of an input- so profits must decrease.*

The fact that these functions in (2.2) are the solutions to a maximization problem of a specific form, the profit maximization problem, will imply certain restrictions on the behaviour of the demand and supply functions (Varian, 1992). First both functions are *homogeneous of degree zero* in all prices. This implies that if, for instance, all prices are doubled, and the levels of goods demanded and supplied by a profit-maximizing firm will not change. Moreover, we have seen in the above that the profit function is homogeneous of degree one in prices; this implies that the partial derivative of a homogeneous function of degree one is homogeneous of degree zero (Chiang, 1985). This property has an important implication of profit maximizing behaviour: an immediate way to check whether some observed behaviour could come from the profit –maximizing model is to see if

supply and demand functions are homogeneous of degree zero. Moreover, if we observed that some firm's demands and supplies changed when all prices doubled and nothing else changed, we would have to conclude that this firm was not maximizing profits in the first place.

In estimation, thus, all that is necessary is to find a functional form with the required properties. In general we want to choose a parametric form for which some values of the parameters satisfy the restrictions imposed by the theory (Abrar, 2001). Then we can estimate the parameters and test the hypothesis that the estimated parameters satisfy the relevant restrictions imposed by the theory (Patterson, 2000).

Two different approaches have been taken in the estimation of the systems with respect to the theoretical constraints (Green, 2000). The first is to estimate the total system without any constraint and to test for the constraints thereby providing a test of profit maximization (Abrar, 2001). The tests of symmetry and homogeneity are standard tests on linear transformations of parameters. The monotonicity of the profit function is usually checked by verifying that its first derivatives have the correct sign (i.e. positive with respect to output and negative with respect to increase in prices). The second approach requires performing estimation under constraints, i.e. imposing the homogeneity and symmetry conditions of the parameters (Saduole and de Janvry, 1995).

To determine which functional form (Translog or quadratic profit functions) best describes a given set of data, comparison can be made based on goodness-of-fit and other diagnostic tests and conformity to neo-classical assumptions (Abrar, 2001). The goodness-of-fit

criteria include: adjusted R-squared, root mean squared error (root MSE), Ramsey RESET test, Akaike information criterion (AIC). Diagnostic criteria: Cook-Weisberg test for heteroskedasticity, a measure of variance information factor (VIF) for multi-collinearity can be used (Green, 2000; Patterson, 2000).

The derived system is then estimated using either the Generalized least squares (GLS) or ordinary least squares. The GLS estimator is desirable than the Ordinary Least Square provided the disturbances of the equations are highly correlated (Patterson, 2000). However, the disturbance variance,  $\sigma^2$  is rarely known so an alternative estimator will be required since in this case GLS is not feasible. Under such circumstances, the relevant procedure is the two-step Feasible Generalized Least Squares (FGLS) or Maximum Likelihood estimation methods (for details see Green, 2000).

Similarly, systems of output supply and input demand can be derived from the *cost function*. Like the profit function, the cost function completely characterizes the producer's behavior, as it includes both the technological constraint from the production function and the behavior of the producers (Sadoulet and de Janvry, 1995:p.67). The cost function is positive; it is non-decreasing, concave, continuous, and homogenous of degree one in input prices. It is also non-decreasing in the level of output and doesn't include the fixed costs. By the Shephard (Hotelling Lemma) duality theorem, the input functions are the derivative of the cost function with respect to the input prices (Varian, 1992):

$$\frac{\partial c(w, z, p)}{\partial w_i} = x_i.$$

b) The second approach, known as the Nerlovian supply response model which is widely used in agricultural supply response empirical analysis explicitly specifies the formation of expectations of farmers for unknown future prices and the adjustment lags in production, (Alemayehu, 2002; Colman and Young, 1989).

The rationale for the Nerlovian models is that, because of the time lag involved in agricultural production, modeling the formation of expectations is thus an important issue in the analysis of agricultural supply response. Particularly for perennial crops the observed quantities may differ from the desired ones because of adjustment lags in the reallocation of variable factors and when the price of a crop changes it may take several years before farmers can reach their desired production patterns at the new price (Alemayehu, 2002)

Supply response in the General Nerlovian model can be formulated in terms of *yield, output response of crops* or *area*. For instance, the desired area to be allocated to crops in period  $t$  is a function of expected relative prices and a number of shifters and is written as follows (Sadoulet and de Janvry, 1995):

$$q_t^d = \alpha + \beta P_t^e + \theta Z_t + u_t \dots\dots\dots (2.3.)$$

Where,  $q_t^d$  is the desired cultivated area in period  $t$ ;  $P_t^e$  is the expected price (or, more generally, vector of expected relative prices including the price of the crop itself, prices of competing crops, and factor prices;  $Z_t$  is a set of other exogenous shifters, principally private and public fixed factors and truly exogenous such as weather;  $u_t$  accounts for unobserved random factors affecting the area under cultivation.

Because full adjustment to the desired allocation of land may not be possible in the short run, the actual adjustment in area will be only a fraction  $\delta$  of the desired adjustment and can be represented as:

$$q_t - q_{t-1} = \delta(q_t^d - q_{t-1}) + v_t, \quad 0 \leq \delta \leq 1 \dots\dots\dots (2.4.)$$

Where  $q_t$  is the actual area planted of the crop,  $\delta$  the partial-adjustment coefficient, and  $v_t$  is a random term with zero expected value.

Moreover, the price the decision maker expects to prevail at harvest time cannot be observed. Therefore, one has to specify a model that explains how the agent forms expectations based on actual and past prices and other observable variables.

For instance, in a formulation that represents a *learning process*, farmers adjust their expectations as a fraction  $\gamma$  of the magnitude of the mistake they made in the previous period, that is, of the difference between the actual price and expected price in t-1, which can be written as follows: (Patterson, 2000):

$$p_t^e - p_{t-1}^e = \gamma(p_{t-1} - p_{t-1}^e) + \omega_t, \text{ or} \\ p_t^e = \gamma p_{t-1} + (1 - \gamma)p_{t-1}^e + w_t, \quad 0 \leq \gamma \leq 1 \dots\dots\dots (2.5.)$$

Where  $p_{t-1}$  is the price that prevails when decision-making for production in period t occurs,  $\gamma$  is the adaptive – expectations coefficient, and  $w_t$  is a random term, with zero expected value.

Since  $p_t^e$  and  $q_t^e$  are not observable, we can eliminate them from equations (2.3), (2.4), and (2.5). Substituting from equations (2.3) and (2.5) into equation (2.4) and rearranging gives the reduced form:

$$q_t = \pi_1 + \pi_2 p_{t-1} + \pi_3 q_{t-1} + \pi_4 q_{t-2} + \pi_5 z_t + \pi_6 z_{t-1} + \epsilon_t \dots\dots\dots (2.3.)'$$

$$\pi_1 = \alpha_1 \delta \gamma,$$

$$\pi_2 = \alpha_2 \delta \gamma,$$

$$\pi_3 = (1 - \delta) + (1 - \gamma),$$

Where,  $\pi_4 = -(1 - \delta)(1 - \gamma),$

$$\pi_5 = \alpha_3 \delta,$$

$$\pi_6 = -\alpha_3 \delta (1 - \gamma),$$

$$\epsilon_t = v_t - (1 - \gamma)v_{t-1} + \delta u_t - \delta(1 - \gamma)u_{t-1} + \alpha_2 \delta w_t.$$

Equation (2.2.)' is the estimable form of the Nerlovian Adjustment supply response model (Abebe, 1998). This reduced form is over identified, since there are six reduced-form coefficients  $\pi$  but only five structural parameters ( $\alpha_1, \alpha_2, \alpha_3, \gamma,$  and  $\delta$ ).

To obtain a unique solution for the latter, a nonlinear constraint must be imposed on the parameters of the reduced form (Sadoulet and de Janvry, 1995):

$$\pi_6^2 - \pi_4 \pi_5^2 + \pi_3 \pi_5 \pi_6 = 0.$$

On the other hand, a simple Nerlovian model, in contrast to the Nerlovian adjustment supply response model, includes neither adjustment nor expectation variables. It usually includes lagged price, lagged yield and trend variables to capture “other factors” and estimation is invariably undertaken using simple OLS (Alemayehu, 2000: 122).

Given the generally unsatisfactory performance of Nerlovian models, other specifications of the formation of product price expectations have been sought (Sadoulet and de Janvry, 1995 p.98). Alternative approaches basically fall into three categories: those that rely on econometric techniques to identify a lag structure from past prices; those that make use of

additional information available to producers about future prices; and the rational expectations approach that relies on economic theory to specify the mechanism of future price formation( for details see, Alemayehu ,2002 and Green,2000).

In empirical research various types of *General Norlovian Supply models* have been constructed to study the supply response agricultural products. As noted in Alemayehu (2002) the first attempt to model supply response in perennial crops is Bateman's (1965) model of cocoa supply in Ghana. The model uses expected producer prices for cocoa and competing crops, such as coffee. Within this model the dependent variable is the additional acreage under the planted crop for each year and other non-price factors are ignored completely.

In variants of this approach, economists have tried to study the supply response of cocoa in Ghana (Walter et al 1998). Walter et al (1998) argued that because cocoa is a perennial crop, the technique in question is relatively complicated, reflecting two basic moments of choice for the farmer: the choice of planting and the choice of maintenance and harvesting intensity, given the available stock of cocoa trees. Therefore, the cocoa supply function is derived in a two-step approach by estimating an [average] capacity equation and an actual supply function. Estimation takes place by using aggregate time series data. Under this set up the 'average capacity' equation, in which so-called 'normal production' is the dependent variable. Normal production represents the production quantity that would normally be expected to be produced by the average tree capacity in that year. In its basic form, this function looks as follows:

$$N_t = a_0 + a_1 \sum_{i=1}^n b_i T_{t-i} \dots\dots\dots (2.6.)$$

Where  $N_t$  is the normal production in year  $t$  (kg),  $b_i$  is the yield coefficient for vintage  $i$ ,  $T_{t-i}$  is the number of trees planted in year  $t-i$ ,  $n$  is the average tree life and  $a_i$  are parameters ( $i=0, 1$ ).

Actual production figures are used as the dependent variable in a first estimation of the average capacity equation. Some also use additional acreage under the planted crop as the dependent variable (see Alemayehu, 2002: 122; Abebe, 1998). Because the equation's parameters are expected to be distorted by short-term influences, a second 'short-run fluctuations' cocoa output equation is formulated as follows:

$$\ln Q_t = b_0 + b_1 \ln N_t + b_2 \ln P_t + b_3 \ln R_t \dots\dots\dots (2.7.)$$

Where  $Q_t$  is the cocoa production in year  $t$ ,  $N_t$  is the normal production (adjusted in every run by using the estimation results of the parameters of equation (a) ),  $P_t$  is the current cocoa producer price,  $R_t$  is the rainfall index ( of different influencing years) and  $b_i$  are parameters ( $i=0,1,2,3$ ).

Actual cocoa production is the dependent variable in this equation. Improved estimates of normal production are generated by subtracting the estimated short-term effects of rainfall and prices. Subsequently, the new estimates of normal production are used as the dependent variable in a second run of equation (2.6). This iterative procedure continues until improvements from a statistical point of view become negligible. Short un-price elasticities can be derived as ( $b_2$ ) from the final estimation results of equation (2.7) (Batman, 1974).

In sum *Nerlovian models* are quite practical and their numerous variants have been applied to many crops in many countries. However, it is fair to say that, compared with a correct theoretical specification of supply response as derived from theory of producer behavior (optimizing behavior with respect to current production, given a fixed endowment of inputs), many Nerlovian models formulations have not been careful about specification of the estimated models (Abebe, 1998; Sadoulet and de Janvry, 1995). Specifically, the estimated supply functions should be *homogeneous of degree zero in prices*, explicit role of fixed factors etc. are not generally included. Moreover, like most time series analysis, Nerlovian models, suffer from aggregation problem, since there is no reason to assume *a priori* that the theory holds for an aggregate of firms, even if it holds for each firm separately (Shumway, 1995). Last but not least, Nerlovian models suffer from data limitation to formulate and estimate econometric models, particularly in low-income countries, where statistical services are often of a poor quality or simply not available (Walter et al, 1998). However, this is not to claim that the latter (theoretical specification) approach is without problems. This is mainly because it is more stringent on assumptions of the behavior of the markets (eg. wage labor is assumed rather than family labor (Abebe, 1998).

c) Finally, the estimation of structural models of supply response and demand equilibrium approach includes both prices and quantities are endogenous. To estimate systems structural equations techniques such as two stage least squares or maximum likelihood have better statistical properties (Green, 2000; Varian, 1992).

## 2.2. Agricultural Supply function

Economic theory suggests that the market supply of a product will depend on its price, prices of other competing products and the prices of inputs into the production process. This relationship (*supply function*) can be written mathematically as follows (Ellis, 1998):

$$Q_i = f(P_i, P_j, P_1, \dots, P_n) \dots\dots\dots (2.8)$$

Where,  $Q_i$  = denotes the market supply of a product,  $i$

$P_i$  = denotes its market price

$P_j$  = prices of alternative products, 'j' and

$P_1, \dots, P_n$  = the set of 'n' input prices.

If for the moment we assume that the prices of other products and inputs are held constant, we can trace out the relationship between the supply of the product and its own price, i.e. the supply curve or supply schedule and generally speaking this curve is positively sloped implying as output prices increase supply increases and vice versa for a *profit-maximizing firm* (Colman and Young, 1989).

What is also important is by how much supply will change in response to an increase/decrease in output price. A convenient measure of the responsiveness of producers to price change is termed in the literature the elasticity of supply or, more specifically, the *own-price elasticity* of supply. This is simply a measure that expresses the proportionate change in quantity supplied as a ratio of the proportionate change in price and formally defined as follows (Varian, 1992):

$$E_i^s = \frac{\text{Proportionate change in quantity supplied, } Q_i}{\text{Proportionate change in own price, } P_i}$$

$$= \frac{\partial Q_i \cdot P_i}{\partial P_i Q_i}$$

Thus if  $E_i^s > 1$ , then a 1% change in price induces more than a 1% change in supply and supply is said to be *elastic*; and if the reverse is true supply is said to be *inelastic*.

Turning now to the other parameters of the supply function, say what is the response of supply to an increase/decrease in the *competing product[s]* price, could be shown diagrammatically by an upward /downward shift in the supply function (curve) since producers are encouraged to switch resources to/from the production of the product whose price has increased/decrease, *ceteris paribus*. For a number of analytical purposes we would also like an estimate of the extent of the response to price changes in the competing product. A measure frequently found useful in this regard is known as the *cross-price elasticity* of supply, which is defined as:

$$E_{i,j}^s = \frac{\text{Proportionate change in quantity supplied } Q_i}{\text{Proportionate change in the price of another good, } P_j}$$

$$= \frac{\partial Q_i \cdot P_j}{\partial P_j Q_i}, \text{ for infinitesimal changes.}$$

For a change in the price of a competing crop/product,  $E_{ij}^s$  is expected to be negative, i.e. if  $P_j$  rises supply of  $Q_i$  decreases and the reverse is true.

Economic theory also postulates that the supply curve shifts in response to change in input prices (Abebe, 1998). For instance, if the price of inputs increases, *ceteris paribus*, the supply curve shifts downwards, i.e. output decreases- and if the input price decreases the reverse is true.

Most agricultural economists would not dispute the economic principles, which underlie the *conventional* supply function represented in the above equation (2.8). However, these economists would also point to a number of important omissions in the parameters of the supply function of agricultural outputs (Colman and Young, 1989). To mention some of these: First, it should be noted that several production activities in agriculture involve *joint* products and that the response to a change in the price of one product of a pair of joint products is quite different from that to a change in a price of a competing product. For example, sheep may be reared for mutton and wool; cattle provide beef and hides, etc. An increase in the price of one joint product will cause the supply curve of the other to shift to the right (increase); for example, the supply of mutton will be related positively both to the price of mutton and the price of wool.

Second, the expression in the above equation (2.8) makes no explicit reference to the *state of technology*, and since a major cause of shifts in agricultural supply over time has been improvement in technology, this omission may be particularly serious. Third, the *conventional* supply function does not include shift variables such as natural environment (weather conditions etc.) that are important especially for less developed sub-Saharan African countries.

To summarize, a comprehensive list of factors, which influence the supply of an agricultural product, comprises (Ellis, 1998): the price of the product, the prices of competing products, the prices of inputs, the prices of joint products, the state of technology, the natural environment, the institutional setting and so on.

Thus, by supplementing the parameters of equation (2.8) with the above-mentioned variables in this way, we can develop a supply function which offers a much more accurate description of production in agricultural markets.

Economists have also distinguished between the short- run and long-run agricultural supply functions in their study of the supply responses of farmers (Sadoulet and de Janvry, 1995). The price elasticity, which depends on the impact of the price on the use of variable factors only, is thus a short run concept. If most factors used in agriculture are fixed in the short run, as it is often claimed, then supply elasticity is close to zero. However, price incentives and increased profitability in agriculture will induce adjustment of some of the fixed factors over a longer period of time. Taking proper account of these long-run effects of price incentives, the long-run production response of agriculture would be *greater* than what is captured by considering only adjustments in the variable inputs.

Furthermore, in studying the elasticity of supply response in agriculture, a critical distinction has been made between the response [*elasticity*] of an individual crop and that of broad agricultural aggregates (Colman and Young, 1989). While individual crops do respond to price factors, even in the short-run, the growth in any crop usually takes resources away from other crops. So, generally speaking, the price elasticity of all-agricultural is very low in the short run in contrast to individual crop (Sadoulet de Janvry, 1995).

## 2.3. Empirical literature in some developing countries and Ethiopia

### A) Studies in some developing countries

In empirical studies the trans-log and the normalized quadratic profit functions are used to derive systems of output supply and factor demand (Walter et al, 1998; Fulginiti and Perrin 1990). Fulginiti and Perrin (1990), for instance, estimated a translog model of the agricultural sector in Argentina using time series data over the long period 1940 to 1980. They considered seven crops, three variable inputs, three fixed factors and time- in- years as a proxy for technological change. By applying Hotelling Lemma to the translog profit function (a mathematical detail of the translog profit functional form is presented in Annex 1) they derived the system of output supply and input demand and estimation of the translog system is done on the share equations as follows:

$$s_i = a_i + \sum_j b_{ij} \ln p_j + \sum_m d_{im} \ln z_m,$$

Where  $s_i = p_i q_i / \pi$  is the share of output sale or input purchase in profit.

As the sum of the shares is equal to one ( $\sum s_i = \sum p_i q_i / \pi = 1$ ), the system isn't linearly independent, and one equation has to be eliminated. The coefficients of the eliminated equation are identifiable from the restrictions. The system was estimated with imposition of the symmetry and homogeneity constraints a theoretical necessity.

Moreover, Bapna, Binswanger, and Quizon (1984) specified a log linear profit function and estimated a cropping system for semiarid tropical areas of India, with a 19-year time series of 93 districts.

The translog model which is often interpreted as a second order approximation to an unknown functional form has been widely used for profit (and cost) analysis (for details, see Green, 2000). In addition to its advantage as a good approximation for an unknown function (Chiang, 1984; p.257), the translog model also simplifies computations since it transforms the parameters of the equations into elasticity's or shares.

The normalized quadratic function has also been used in various countries (e.g., Shumway, 1983; Walter et al, 1998). To study the supply response of cocoa in Ghana, Walter et al, 1998, specified a normalized quadratic profit function (a mathematical detail of this functional form is presented in Annex 1). It was assumed in the model that the cocoa farmers use one variable input (insecticide) and two fixed inputs (land and labor). Maize production/price was incorporated as the competing activity since it was '*found*' to be the major marketed food crop in the region where cocoa was grown. *Linear homogeneity* was imposed in the model by deflating profit and the maize and insecticide prices with the cocoa price. The maize, cocoa supply and insect demand functions were derived from the estimated normalized profit function using Hotelling Lemma. Then the system was estimated using the Seemingly Unrelated Regression (SUR) estimation method. SUR is chosen because of the cross-equation restriction of the parameters appearing in more than one equation and the error terms were correlated. The theoretical restrictions were not rejected in their findings. To test for these theoretical restrictions of profit maximizing behavior they applied the following procedure: First, to test whether the profit function is increasing in out put prices they checked if the first derivative (as calculated at sample means) of the profit function with respect to the normalized maize price was positive or

negative and they found to be positive. Second, to test if the profit function is decreasing in input price they checked its first derivative with the price of insecticide and found to be negative. Third, to test whether it is increasing in fixed inputs they checked the first derivatives with respect to the inputs (land and labor) and found positive values for both of them (Walter et al, 1998).

Finally, a study conducted by Alemayehu (2002) specified an export function of primary commodities for African countries. In the study commodity export supply equation of a typical African economy is specified to depict the behavior of producers mediated through the government. The result shows that: real exchange rate has statistically significant elasticity with clear long and short run distinction (this, according to Alemayehu, underscores the importance of this particular specification and the error correction model in estimation); capital formation indicators are also found to have positive elasticities; there is a variation across regions and, estimation with foreign inflow included gives a mixed result.

## **B) Studies in Ethiopia**

A study conducted by Luelseged and Dercon (1994), to investigate the effects of pricing policy on Ethiopian coffee production and the supplies to the official markets, specified a *log-linear* total official supply for coffee using time series data. Luelseged and Dercon (1994) argued that since coffee is a perennial crop and substantial lags (3 to 7 years) exist before a harvest can be obtained from newly planted trees, farmers base their planting decisions (and therefore supply) on their expectations about future prices. Thus, to account

for the lags in production responses they included lagged prices of three (3) years for both coffee and its competing crop *chat*. On the basis of the ordinary least square regression analysis supply response of coffee production was found to be responsive to prices, but this effect was not large. The latter is partly attributed to the relative high price of other competing crops such as khat.

Another micro-based econometric study is Abdurrahman's work (1995) on two districts in Hararghe highlands – an important coffee growing area. Using a survey data of the two districts, Abdurrahman (1995) found a strong short-run (two-year) supply price elasticity value of 0.60, which was statistically significant. Abdurrahman (1995) argued that this short run response implied the reallocation of labor to the cash crop sector and a shift of supply from smuggling to the formal channels. Abdurrahman (1995) also noted that, after liberalization the terms of trade have moved against the agricultural sector in general and food production in particular.

Another study by Yoseph (1994) used a log-log model to estimate the supply price elasticity of coffee, based on a survey conducted in Gomma district, Jimma region. The study showed that the supply price elasticity is not really important. Whereas land and labor were found as crucial inputs. Another finding of the study is that in the sample area coffee producers spend 91.3% of their earning from coffee to purchase food crops. According to Yoseph (1994) there is a huge tendency of farmers to shift to coffee production as the price of coffee increased by 61% while that of food crops (maize and sorghum) increased only by 11% during the period from 1992/3 to 1993/4.

Abebe (1998) estimated the supply response of Ethiopian peasants in cereals (teff, barely, wheat, maize and sorghum) production to price levels. A log-linear dynamic area cultivated response equation was specified in which ad hoc specifications of supply response including partial adjustment and expectations formations are integrated. Price, real exchange rate (to capture the substitution between food imports and domestic production), fertilizer quantity and expected yield were included as explanatory variables. Results indicate that both short- run and long-run supply responses were inelastic to prices. These results were true when cereals were considered in their aggregate or treated individually. On the other hand supply elasticity due to movements in real exchange both for short run and long-run was found to be elastic. Therefore, Abebe (1998) argued, food imports have been competing more with domestic cereal production (particularly with maize and sorghum).

Zerihun (1996) using aggregate time series data examined the relationships between producer prices of food grains and the area of cultivated land. In addition to producer price, dummies for weather and policy change, time trend and lagged production level were entered into the supply equation. Zerihun (1996) argued food grain production changes only slightly following price incentive measures and parameter estimates like weather and previous period production level have the expected signs.

Using a nationally representative rural household survey conducted in 1994, Abrar (2001) tried to determine which functional form (translog or a normalized quadratic profit function) best describes the Ethiopian data. Comparison of the models was done based on goodness-of-fit (adjusted R-squared, root mean squared error) and diagnostic tests

(Cook-Weisberg test for heteroskedasticity, a measure of variance information factor for multi-co linearity). It was found that the normalized quadratic function was superior since it had significant parameters consistent with theory. Otherwise, as Abrar (2001) argued, there is *no clear* theoretical benchmark to determine whether the translog or the normalized quadratic is superior. Moreover, both the primal and dual approaches to study the supply response produced similar results for the underlying data set. That is, there was no remarkable difference in the inferences made from elasticity estimates of the primal and dual specifications.

In the same study, Abrar (2001) examined peasant agricultural crop output responsiveness to price and non-price factors. Two variable purchased inputs, chemical fertilizer and labor and three fixed inputs land (total area under crops), animal power and farm capital were considered. Besides, two 'exogenous controls' –land accesses and rainfall were incorporated in estimation. Results found from the study indicated that the own-price output supply elasticity was very low and output supply was not responsive to fertilizer prices or the wage rate. Non-price factors were far more important in affecting production and resource use than price incentives.

Alemayehu (1999) examined trade liberalization and its implications for the Ethiopian coffee sector using the 'before after approach'. The study shows that the liberalization carried out is strongly associated with an increase in the level of export. On the other hand the micro evidences examined in the same study showed that the supply price elasticity for coffee is either small or statistically insignificant. According to Alemayehu (1999) this implies that price liberalization by itself may not bring a major change in the coffee sub-

sector. The study by Alemayehu (1999) also underscores the problem of ensuring food security by relying on unreliable world primary commodity markets.

Gebisa (1997) dealt with the co- modification of khat and the consequent transformation of the political economy of the Harerge region. In the study it was found that from the mid-1970s on, state intervention was responsible for the accelerated pace of change. The Ethiopian government monopolized agricultural marketing and imposed restriction on the importation of consumer goods, thereby creating a critical shortage of consumer goods. Khat and other primary goods were smuggled out and the result was in the unprecedented growth in the khat sub-sector.

Abdurrahman (2004) attempted to analyze the trends in khat production, marketing domestic and the growth of an international market and the impact of these changes upon the local patterns of production in east Hararghe. In the study it was found that with globalization of khat consumption, the crop found new markets, both within the region of production and internationally. According to Abdurrahman (2004), the export price of khat to Djibouti is set through an agreement between the Djiboutian and Ethiopian governments. Abdurrahman (2004) also noted that farmers are vulnerable to vagaries of the khat market. Farm gate price recently ranges between US cents 45 to USD 1.40 per pound depending on their quality. Khat in Djibouti is sold about USD 11.00 per pound.

In sum, most of the supply response studies in Ethiopia adopt the ad hoc specifications of supply response including partial adjustment and expectation formation and carry estimations using time series data (Abrar, 2001; Abebe, 1998). As noted in the previous

section the major drawback of this approach is its minimal theoretical background. Moreover, most of studies focus either on economic wide policies on export supply response, particularly coffee (Abrar, 2001, Alemayehu, 2003) or on food crops (Abebe, 1998). Although there are some micro-based studies (see for e.g. Abebe, 1998; Abdurrahman, 1995 and Luelseged and Dercon, 1994) most of them focus on examining either on cross-price effect of coffee and khat or on the cross-price of coffee and food crops. That is, they neglect the potential existence of cross-price effect (or substitution) among the crops jointly (particularly, between khat and food crops).

The current study differs because: first, it adopts the micro-economic approach to study the supply response of khat. Particularly, it adopts the profit function (*dual* of the production function) approach for deriving system of output supply and input demand, an approach firmly rooted in neoclassical production theory. Second, the current study does not only attempt to measure the supply response of food grain production to changes in prices and non-price factors, but also the elasticity of substitution of production of food grains to changes in prices of competing cash crops (such as, khat and coffee).

### **Chapter III- The plant chat (khat) and its economic role in Ethiopia**

In this chapter we will attempt to show the economic impact of chat (khat) in Ethiopia at macro level. We will do this by examining its contribution in foreign exchange, employment, tax revenue and income to producers (farmers).

The rest of the chapter is organized as follows: In section (3.1.) a brief review of the plant chat (khat) will be given. In section (3.2.) we will describe the economic role of chat in Ethiopia.

#### **3.1. The plant chat (khat)**

The plant chat (Khat) - the mild stimulant cash crop- is an evergreen perennial shrub plant that belongs to the *Celastraceous* family. It is known with different vernacular names: Khat in English and in Arabic and *chat* in Amharic. *(N.B. In this study we used both names).*

Much of the lore of khat has been passed on orally from generation to generation, leaving inadequate written records largely due to lack of interest in the crop by institutions, policy makers and researchers. Hence, the history of its importance as a crop is neither clear nor certain (Dechassa, 2001).

Some oral traditions claim that khat originated from Yemen. Others, however, claim that it originated from Ethiopia, specifically in Hararghe with a gradual expansion to different parts of Ethiopia, Yemen and other parts of the world.

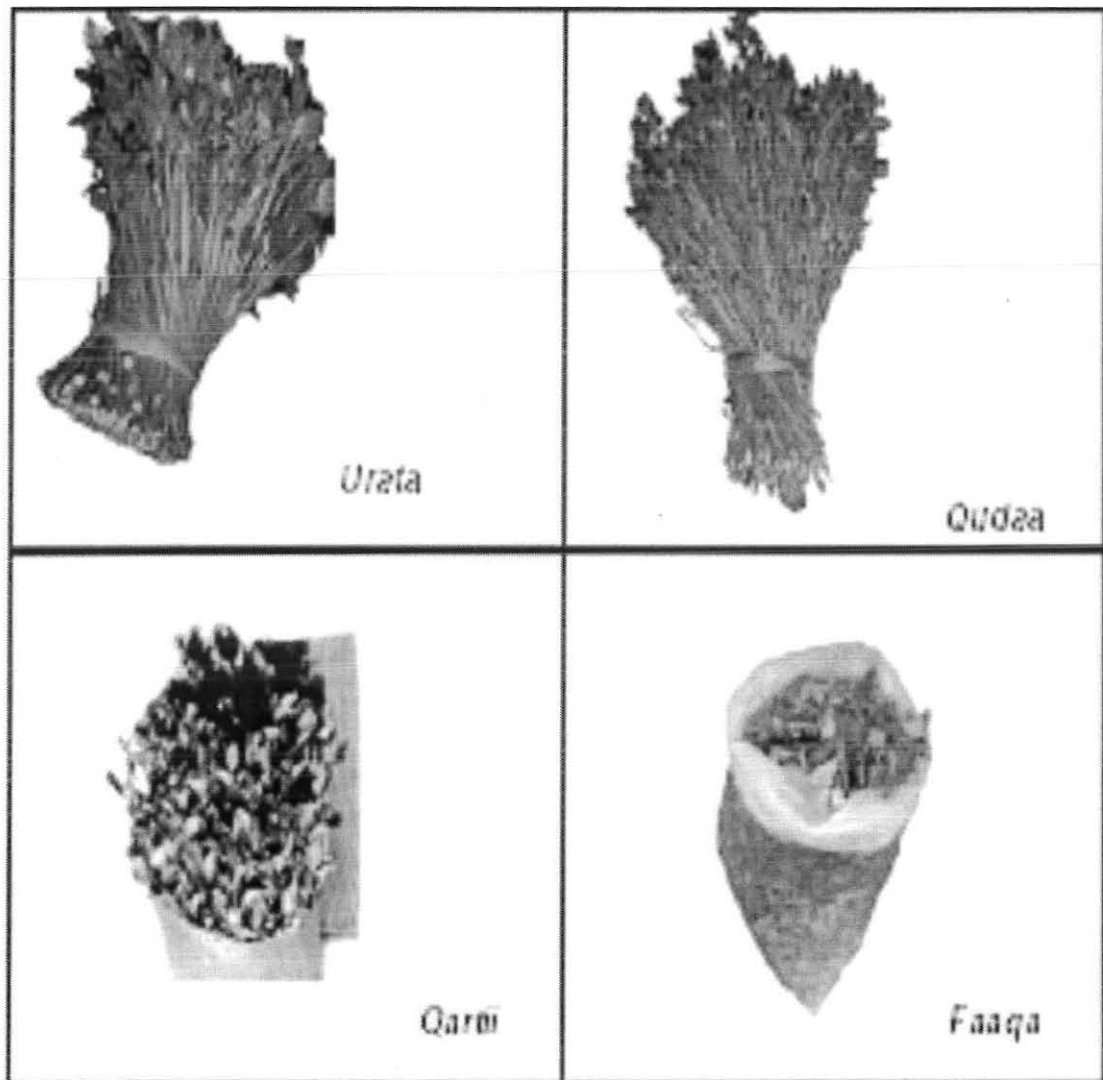
The production of khat is well established in Ethiopia, Eritrea, Somalia, Kenya, Tanzania, Uganda, Burundi, Rwanda, Democratic Republic of Congo, Zambia, Zimbabwe, Southern Rhodesia and South Africa. In East Africa it grows in the range of 1500-2500 meters above sea level. Outside Africa it is planted in the Arabian Peninsula, Yemen, Afghanistan, India and Sri Lanka for consumption and in the USA, UK and France for experimental purposes (for details, visit [http:// WWW.telecom.net et/~undp-eue/](http://WWW.telecom.net.et/~undp-eue/)).

An unpublished study by the Ethiopian Ministry of Trade and Industry in 2005 gives a brief description of khat as follows: khat grows up to 7 meters but occasionally reaches as high as 15 to 25 meters. Leaves are simple, elliptic oblong and are glossy green above but lighter below, leathery and stiff tapering to both ends. The buds and leaves contain an alkaloid and are chewed in a fresh or dried condition as a stimulant. Flowers are small and white. The fruit is smooth and narrow splitting to release narrowly winged reddish when matured. The stem is straight and slender; the bark has different colors depending on the variety and age of the stem and branches. The young branches are smooth and green to pinkish but grey and sometimes rougher and darker on older branches and stems.

Abdurrahman (2004) noted that from planting a stand of chat to regular harvesting normally takes 2 to 3 years. In the first year, farmers prune/harvest a small amount mainly to train and control the growth habit, to initiate more shoots with better twigs and to reduce wind damage. From the second to third year, however, the harvest volume steadily increases over all 8 -10 years period, but afterwards the plant becomes old and needs to be renewed by stumping at soil level or at the middle of the stem (Dechassa, 2001). The young leaves can be harvested gradually throughout the year, but after harvesting, they

need to reach the market still fresh to keep its value (Luelseged and Dercon, 1994 and see Figure -1 for various types of chat).

Figure 1- Different types of marketable products of chat



*Different types of marketable products of Khat*

Source: visit <http://www.togdheer.com/>.

Chat can be grown rain fed and/or irrigated. The crop could be planted either in home garden or in the field and it is often grown in association with different food crops and is highly compatible when intercropped. The practice of row planting and intercropping simplifies agricultural operations besides easing up the existing land shortage. In marginal and steep sloping areas, where other crops can not be grown, pure stands of chat are planted (for details, visit <http://www.togdheer.com/>).

As Dechassa (2001) noted *chat* is tolerant of a wide range of rainfall patterns, the distribution of rains in one season is more critical than the total amount of annual rainfall received. Dechassa (2001) also noted that annual rainfall ranging from 1,000-1,500 mm is considered as ideal for good performance and productivity of the crop.

The production of chat has various advantages(Dechassa 2001 and for details, visit <http://www.togdheer.com/> ): First, processed leaves and roots are traditionally used to treat influenza, cough and for stomach ache; second, chat has a considerable social value as it is served to welcome and entertain guests and collective labor works; third, chat cultivation plays a key role in controlling soil erosion since it is usually planted in rows on hillsides along terraces against slopes in association with different corps; finally, khat is a good source of income to its sellers and producers. Particularly, as it is described in the following section, the contribution of chat production to the Ethiopian economy is increasing from time to time.

### **3.2. Economic Role of chat in Ethiopia**

The agricultural sector is the backbone of the Ethiopian economy; more than 85% of the population is dependent on it for their livelihood and 55% of the GDP originates from this sector. About 90% of export earnings are also contributed by this sector (NBE, Annual Report, 2003/04).

The cropping pattern of exportable is a proof of the immense wealth of this country. In statistical tables these crops are usually categorized into eight groups. These groups are cereals, pulses, oilseeds, vegetables, root crops, fruit crops, stimulant crops (khat, coffee & hops), and sugar cane (Central Statistics Authority, 2003/04). Coffee, the most important cash crop is Ethiopia's gift to the world. Coffee has been the major source of foreign exchange to the nation and a source of livelihood for a large number of farmers.

Recently the economic role of chat is also increasing from time to time. In the remainder part of this sub-section, therefore, we will briefly describe the pattern of production (employment) in the chat sector, the contribution of chat to the nation's foreign exchange supply and to the government tax revenue.

#### **a) Geographical distribution and pattern of chat production**

Currently, chat is being grown for sale not just in its traditional areas in Hararghe (Oromia), but also in Jimma, Shashemene, Sidamo, Kembata, Guraghe, even as far as Gojjam and Tirgray (Lueleseged and Dercon, 1994).

Data obtained from the 5th round of Ethiopian Rural Household Survey (ERHS) shows that of the total chat production of 19,885 kg in 1999, Oromia region produced 16,427.50 kg (or 82.61%) and the rest 3,457.50 kg (or 17.39%) was produced by the South Nation and Nationalities Peoples (SNNP) region. Moreover, out of the 21.95 hectares of total area of land under chat cultivation, 18.21 hectare (or 82.9%) and 3.61 hectare (or 16.4%) was in the Oromia and SNNP regions respectively.

On the other hand, a recent agricultural sample survey conducted by the Central Statistics Authority indicates that, out of the total 933,398 kg chat produced in (2003/04), Oromia, SNNP, Somalia and Amhara regions produced 543,737kg (or 58.25%), 238,109kg (or 26%), 104,138kg (or 11.16%) and 13,566kg (or 1.45%) respectively. And out of the total 111,578 hectare area under chat cultivation, 75,196 hectare (or 67%), 22,570 hectare (or 20%), 7,984 hectare (or 7.15%) and 2,718 hectare (or 2.44%) was in the Oromia, SNNP, Somalia and Amhara regions respectively. This shows that production of chat (hence employment) which was concentrated in Hararghe (Oromia) region has expanded to different parts of Ethiopia (See also Figure 2 below).

Figure 2- Map showing distribution of khat in Ethiopia



Area of khat cultivation



Area of intensive khat cultivation, consumption and Commercial business

Source: visit [WWW.telecom.net et/~eue/](http://WWW.telecom.net.et/~eue/)

Official data covering a long period of time couldn't be found to show the number of peasant households engaged in the production of chat, area under khat cultivation, income to farmers and the trend in its volume of production. Trade statistics in the past had been repressed since chat was considered as a drug (Luelseged and Dercon, 1994:p.62). The Central Statistics Authority has recently started to include data on chat production and area under chat cultivation in its Agricultural sample surveys. Thus using data obtained from the Central Statistics Authority and from the Ethiopian Rural Household Survey conducted in 1999 we will describe the pattern of area under chat cultivation, production and yield of chat.

Table 1(below) presents estimate of area, production and yield of chat for private peasant holdings obtained from the Ethiopian Central Statistical Authority.

Table 1 Estimate of Area, Production and Yield of chat and coffee

Crop	Area in hectare			Production in quintal			Yield (quintal/hectare)		
	2001/02	2003/04	% change	2001/02	2003/04	% change	2001/02	2003/04	% change
chat	96,066	111,578	16.15	796,520	933,398	17.18	8.29	8.37	0.97
coffee	243,834	232,439	-4.67	1,571,753	1,261,880	-19.72	6.45	5.43	-15.81

Source: Central Statistical Authority, Agricultural Sample Survey, 2003/04

As can be seen from table- 1, volume of chat production, area under chat cultivation and yield (quintal/hectare) has increased. In contrast the opposite trend is observed for coffee. The increase in the yield of chat production, therefore, coupled with the increase in the unit export value of chat (see figure 3 below) could be the reason that farmers are encouraged to invest in chat production. Data from the same source also shows that number of peasant holders in chat cultivation were about 1,731,224 in 2003/04; for comparison 2,420,827 number of peasant holders in coffee cultivation.

Moreover, data obtained from the 5<sup>th</sup> round of the Ethiopian Rural Household Survey (ERHS), indicates that 19,885 kg of chat was produced during the survey period in 1999. This represents about 0.89% of the total agricultural output (including chat) of 2,219,671 kg. In the survey it was also found that area under chat cultivation was 21.95 hectares, representing about 1.07% of the total area under cultivation. For comparison, area under coffee cultivation during the same period was 2.74%.

Data obtained from the 5th round of Ethiopian Rural Household Survey (ERHS) also indicate that total labor of 341,650.60 (in terms of man -hours) was employed in the production of various types of crops including chat by 6983 households(sample units). Out of the total 341,650.60 man-hours, 4891.51 man-hours (or 1.43%) were employed in the production of chat. For comparison, 31,542 man-hours (or 9.23%) were employed in coffee production.

Total revenue from sales of various crops (including khat) for 1830 households included in the survey was 799,484.40Birr. The share of 110 households who produced and sold chat

was 85,809 Birr (or 10.73%). The remaining 713,675.00 Birr (or 89.27%) was the share of 1720 households who produced and sold crops other than chat. As can be seen from this, production of chat was a good source of income to about 6% ( $=110\text{households}/1830\text{households} \times 100\%$ ) of the 1830 peasant households included in the survey. Moreover, the average income of a household producing and selling chat was 780 Birr ( $=85809\text{Birr}/110\text{ households}$ ). The average income of a household who produced and sold other crops was 414.93 Birr ( $713,575\text{ Birr}/1720\text{households}$ ). Thus it can be concluded that in contrast to other crops, production and investment in chat is a lucrative business. This in turn implies that farmers are attracted to produce more of chat since its nominal return is quite significant, relative to other crops.

Selling of chat has also been a good source of income and employment in the urban part of Ethiopia. Chat is now being sold in various cities like Addis Ababa, Nazareth, Shashemene, Awassa, and even as far as Bahrdar, Gondar and Mekelle.

Table 2 presents data on the number of chat retailers in Addis Ababa from 1993 E.C. to 1997 E.C. The data is obtained from the Addis Ababa City Government Trade and Industry Development Bureau.

**Table 2-** Number of chat retailers in Addis Ababa City

Year*	Number of retailers**
1993	29,355
1994	32,877
1995	37,148
1996	49,641
1997***	51,033

\*Ethiopian calendar

\*\* does not include those *unlicensed* by the bureau

\*\*\* up to the month of Miazia

**Source:** Addis Ababa Government Trade and Industry Development bureau.

Data on net- income and persons employed for all these retailers could not be found. We therefore, informally interviewed ten different chat sellers, randomly selected from the ten sub-cities in Addis Ababa. We asked them to inform us their average net-income per month and number of persons employed by each of them. According to these retailers, the average monthly net-income earned by each sellers ranges from Birr.2000.00 to Birr 2500.00. The respondents also informed us that a seller employs 2 to 3 persons (usually youngsters). Thus, as we see from table-3 , in 1997 there are about 51,033 chat retailers and if each of them employees 2 to 3 persons, the chat sector in Addis Ababa has been a good source of employment to more than 153,099 [=51,033 +(2 x 51,033)] citizens.

During our field survey in the city we also interviewed (informally) ten different consumers who have been chewing chat for the last ten years. These consumers, who were not willing to mention their names, told us that they pay Birr 10.00 for a handful of chat. According to these individuals the same quantity and quality of chat was being sold for about Birr 5.00 some 8 to 10 years ago. We can see from this that the selling price of

chat in Addis Ababa has been increasing over the past years. In reply to our question whether they have reduced the quantity they demanded in response to the increase in the price of chat, all the interviewed consumers replied they have not reduced. We found this to be consistent with the usual view that the price elasticity of stimulant crops (commodities) is price inelastic. This could be the reason that encourages farmers to shift into the production of chat away from other food crops, which are, generally speaking, price elastic.

#### **b) The contribution of khat to the foreign exchange supply**

Khat from Ethiopia is exported to various parts of the world including: Djibouti, Somalia, UK (London) and a number of Arab Countries (Luelseged and Dercon, 1994). Particularly Djibouti and Somalia are the two major chat importers from Ethiopia. Data obtained from Ethiopian Customs Authority (the latest available data) indicate that 53.86% and 44.21% of the total export of 72,472 tones of chat, in 2002, was exported to Djibouti and Somalia, respectively.

The contribution chat to the nation's foreign exchange supply is increasing from time to time. This can be seen from the increase in its share of export as presented in table -3.

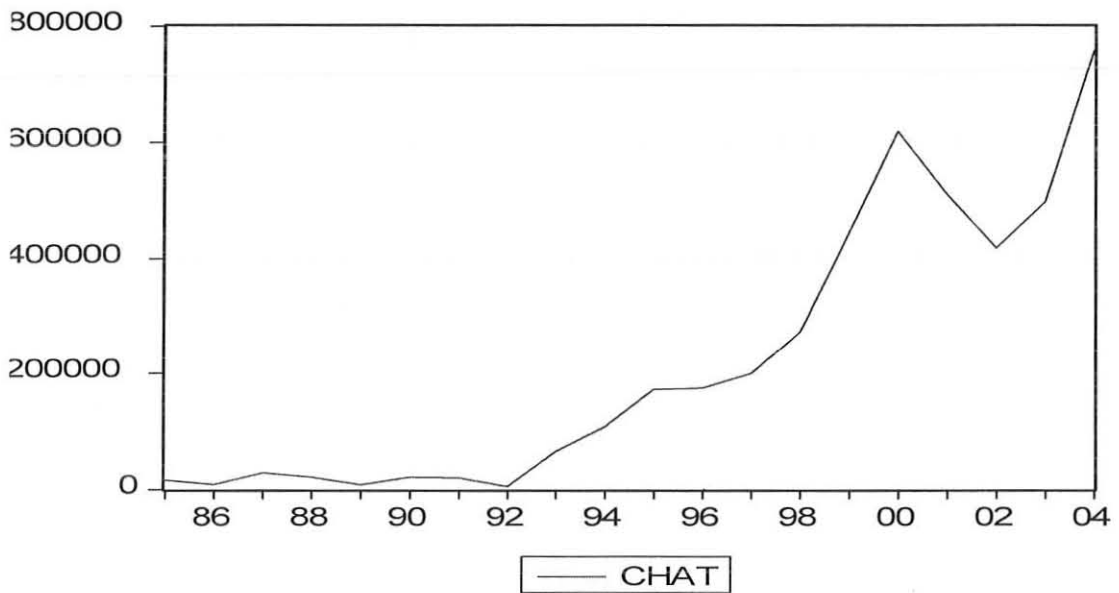
**Table 3 Export share of major commodities (in %)**

commodities	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
coffee	75%	70%	57%	60%	60%	63%
chat	16%	20%	19%	18%	21%	25%
hides & skins	8%	9%	23%	20%	18%	12%

Source: National Bank of Ethiopia, Annual Report, 2003/04.

Moreover, both the value and volume of chat export has shown an increasing trend over the past decade. As can be seen from figure- 3 value of chat export has been increasing starting from 1992 and continued till 2000. It then declined for two consecutive years in 2001 and 2002, even though its levels were higher than 1980s and 1990s. Recovery started again and reached the highest level in 2004.

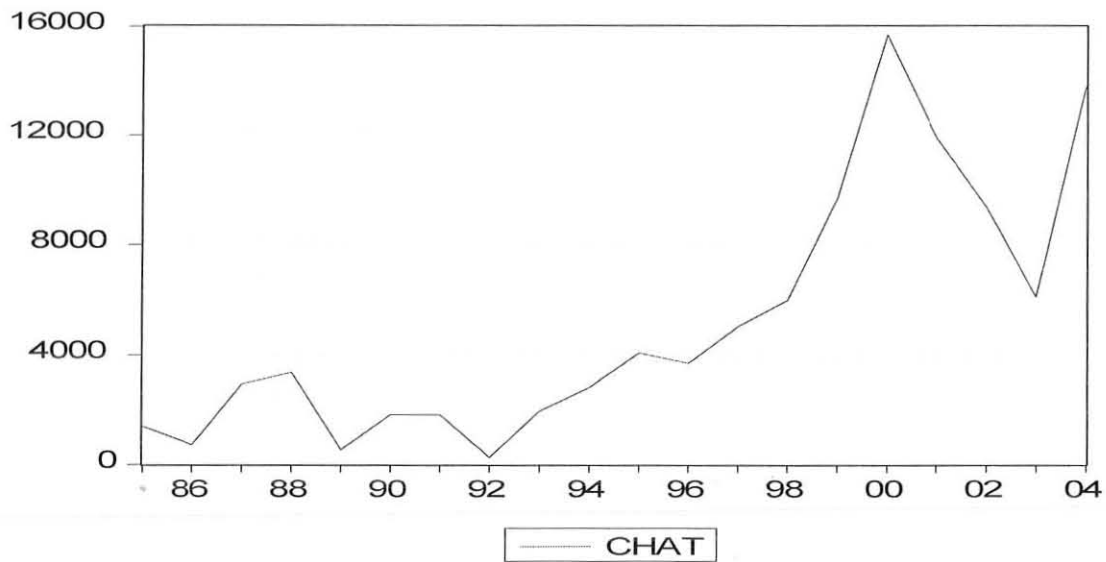
Figure 3- Value of chat exports (in thousands of Birr)



**Source:** National Bank of Ethiopia, Annual Report, 2003/04

Figure 4 (see below) shows the volume of chat export since the beginning of 1986, data availability permitting. A continuous increase in export supplies can be observed starting from 1992 until 2000 before it starts to decline in 2001, but at levels higher than 1980s and 1990s. Finally, a recovery can be noticed in the year 2004, even though it reached at level lower than in 2000. From Figure 4 it can also be seen that despite the severe drought years recorded in Ethiopia in the past years (for instance, in 1993-94) the export supply (production) of chat has increased.

**Figure 4- Volume of chat exports (in metric tones)**

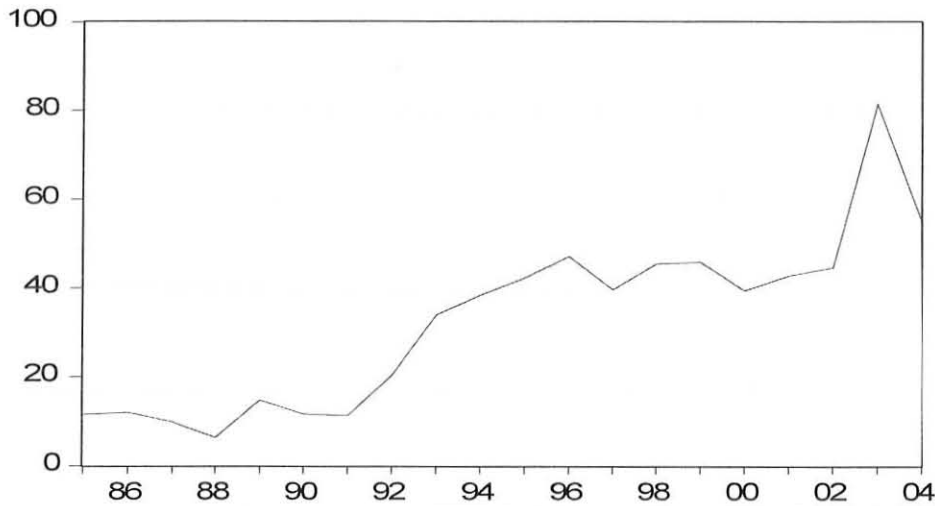


**Source:** National Bank of Ethiopia, Annual Report, 2003/04

The increase in the volume of export (and hence production) of chat can be explained by the increase in its unit export value, defined as Birr per kilogram. As can be seen from figure-5(see below), the unit export value of chat has been steadily increasing, with mild fluctuations, since 1988. It reached the highest level in 2003. Although it started to decline after that the level it reached was higher than previous periods.

Figure 5 also illustrates the attraction to enter in to chat production. Beginning from 1988 up to 2004 it can be seen that the unit export value of chat has been increasing reflecting the incentives to produce more of khat. The increase could be demand led since the substantial habit formation involving in the consumption of chat. Moreover, the value and volume of chat has declined from 2000 to the end of 2002, as is shown in figure 3 and figure 4 respectively. This could be explained by the fall in the unit export value of chat as is shown in figure 5(see below).

**Figure 5- Unit export value of chat (Birr/kg)**



Source: National Bank of Ethiopia, Annual Report, 2003/04

### **c) The contribution of chat to the government tax revenue**

Apart from generating foreign exchange and creating employment opportunity to the country, chat has been a good source of tax revenue to the government, particularly to the regional governments.

Although, chat has been produced in Ethiopia for decades, there was no tax law or directive by the government in regard to the payment of tax, either on the sale or production of chat. It was only in 1987, for the first time, the government issued a proclamation no.309/1987, which was a “proclamation to provide for the payment of tax on the sale of chat (see Negarit Gazette, 46<sup>th</sup> year, No.10). The proclamation had the objective of “levying tax on the sale of chat to generate additional revenue to finance various development activities.” In the proclamation it was declared that: 1) any person possessing, carrying or otherwise handling chat for sale or destined for sale shall be liable

to pay the tax determined under the proclamation; 2) the tax shall be charged, levied and collected at the following rates : a) on the sale of chat irrespective of its destination or use at the rate of Birr.2.00 per kilogram; b) on the sale of chat destined for export at the rate of Birr 5.00 per kilogram, in addition to the rate fixed under 2 (a) above.

Data over a long period of time and for all the regions could not be found to examine the importance of chat as source of tax income to the country. However, volume of chat export data from the National Bank of Ethiopia are used to estimate tax revenue collected from chat export. This is presented in table 4.

**Table 4- Tax income from chat export**

year	Quantity of khat (in metric tones)*	Value of tax from chat ( in thousands of Birr)**
1985	1380.00	9660.00
1986	711.00	4977.00
1987	2931.00	20517.00
1988	3363.00	23541.00
1989	537.00	3759.00
1990	1816.00	12712.00
1991	1816.00	12712.00
1992	251.00	1757.00
1993	1936.40	13554.80
1994	2808.48	19659.36
1995	4073.27	28512.89
1996	3698.29	25888.03
1997	5031.20	35218.40
1998	5980.93	41866.50
1999	9702.07	67914.47
2000	15683.65	109785.53
2001	11927.73	83494.08
2002	9376.67	65636.66
2003	6105.58	42739.07
2004	13797.92	96585.41

\*Source: National Bank of Ethiopia, Annual Report, 2003/04

\*\*Own calculation{Quantity of chat x ( 5 +2)/kg}

Moreover, data on tax revenue from chat for the period 1988 E.C. to 1996 E.C., for the Oromia regional government is available and is presented in table 5. The description at regional level is also believed to give us a good estimate of the contribution of chat to tax revenue at national level. We chose the Oromia region because it is one of the largest regions where chat is produced (see p.41 of the current study).

As can be seen from table 5 and Figure 6 (see below) tax revenue from chat for Oromia region has been increasing continuously from 1988 till 1996. Particularly, it started to show a dramatic change starting from 1992 and reached a higher amount of Birr 147 million in 1996. Although, it slightly decreased in 1993 and 1994 as compared to 1992, it was still a higher amount than in the initial period of 1988.

Table 5 also shows that share of chat tax on total tax revenue for the Oromia region. In 1988 share of chat tax on total tax revenue was 27.19 %; it then showed a declining and rising trends, until it reached a higher level of 28.8% than the initial period.

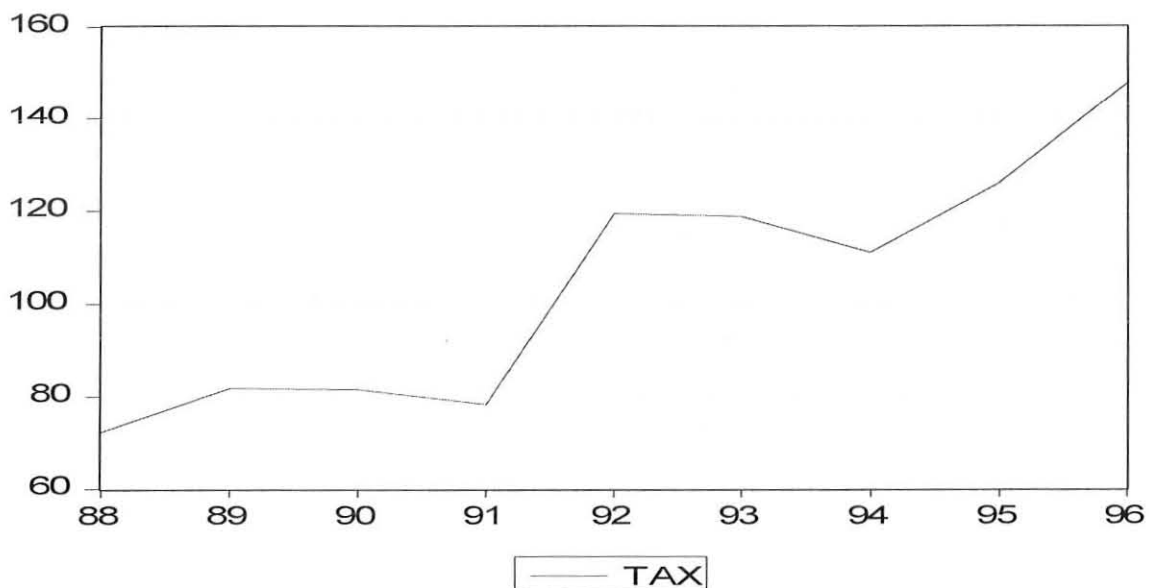
The reason for the dramatic change in tax income from chat starting from 1992 could be the Oromia region raised the tax rate from Birr 5.00 per kilogram to Birr 6.00 per kilogram.

**Table 5- tax revenue from chat of the Oromia Regional government ( in Millions of Birr)**

Year (Ethiopian calendar)	income from tax on chat	total tax revenue	% of chat tax in total tax revenue
1988	72.235	265.643	27.19
1989	81.723	303.864	26.89
1990	81.485	306	26.63
1991	78.248	316.63	24.71
1992	119.481	383.569	31.15
1993	118.875	393.431	30.21
1994	111.051	418.633	26.53
1995	125.949	444.472	28.34
1996	147.617	512.498	28.8

**Source:** Oromia Finance and Economic Development Bureau

**Figure 6- tax revenue from chat for the Oromia Regional government (in millions of Birr)**



**Source:** Oromia Finance and Economic Development Bureau

## **Chapter IV - Supply response and input demand estimation for chat and food crops production in Ethiopia**

The current study aims at identifying and estimating the factors that affects the supply of *chat*. Particularly the analysis will include specifying a system of output supply and input demand, so as to estimate the own-price elasticity of chat and its cross-price elasticities with respect to coffee and food crops.

It is expected that the *own-price elasticity* of *chat* to be positive; other non-price factors such as land are also expected to be major determinants of *chat* supply or production. On the other hand, the *cross-price elasticity* of chat is expected to be negative – indicating substitutability of *chat* production with coffee and other food crops.

### **4.1. Modeling framework**

As we have discussed in the previous chapter there are alternative approaches to estimation of elasticities of supply response are available both at the structural and reduced form levels. In the current study we followed the direct estimation of system of out put supply and input demand as derived from a profit function approach. This approach as compared to the other approaches, particularly the Nerlovian models, is based on theoretical specifications of supply response. Moreover, since it uses micro-level data it doesn't suffer from the *aggregation* problem, unlike most approaches which use time series analysis (see p.23 of the current study).

Under the direct estimation of supply response derived from a profit function approach, it is assumed that profit-maximizing behavior can be described by a *profit-function*- the so-called *dual* of the production function (Varian, 1992; Walter et al, 1998). Assuming that farmers choose combinations of the variable inputs and outputs that will maximize profit, the restricted profit function defined as the excess of total value of output over the costs of variable inputs, can be expressed as (Abrara, 2001; Sadoulet and de Janvry, 1995):

$$\Pi(p, c) = \text{Max}_q (p \cdot q / q \in T(c), c \in C) \dots\dots\dots (4.1)$$

where  $q$  is a vector of outputs ( $q_i > 0$ ) and inputs ( $q_i < 0$ ),  $p$  is a vector of output and input prices,  $c$  is a fixed or environmental factors (such as fixed land endowment, weather and government policies, captured by  $C$ ) and  $T$  summarizes the state of the technology constrained by  $c$ .

For the profit function to represent consistent profit-optimizing behavior, however, it should satisfy some theoretical restrictions: namely, homogeneity, symmetry, monotonicity and convexity (Varian, 1992).

Thus using the derivative property (Hotelling lemma) to the above equation the output supply and input demand functions are derived as follows (Walter et al, 1998):

$$\frac{\partial \Pi}{\partial p_i} = q_i \quad \text{and} \quad \frac{\partial \Pi}{\partial p_k} = - q_k \dots\dots\dots (4.2)$$

Where  $i$  and  $k$  represent output and input respectively. The minus sign ( $- q_k$ ) comes from the fact that we are increasing the price of an input- so profits must decrease.

## **4.2. Data and description of variables**

### **a. Data**

The data used for estimating the model come from the 5<sup>th</sup> round of the Ethiopian Rural Household Surveys (ERHS) conducted in 1999 by the department of Economics of Addis Ababa University, Institute of Development Research, Addis Ababa University and Center for the Study of African economies, Oxford University.

The survey was undertaken in the four largest regions (where well over two-thirds of the population lives), from which eighteen Weredas are randomly selected. It is believed that the survey to represent the diversity of farming systems in the country. The considerable geographic dispersion of the sampled villages on the one hand, and large differences in accessibility to input and output markets on the other, means that, there are large variations in prices faced by different households. This is an important feature of the data as such price variability is essential to estimate supply elasticities from cross-sectional data. Moreover, other topics addressed in the survey include household characteristics, agricultural and livestock information, food consumption, production, marketing etc.

Data from only two regions, Oromia and South Nations, Nationalities and Peoples (SNNP) is used. These two regions produced 84.25% of the total chat produced in survey (1999). Smaller number of observations are used than those included in the original data due to the removal of observations with missing values for some of the variables included in the study. This resulted in a sample size of 236 observations.

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## **b. Description of variables**

In the current study we considered a system of production with three crops (*chat*, *coffee*, and *food crops*), produced with two variable factors (*labor & fertilizer use*), and two fixed factors (land & animal power).

Outputs (*chat*, *coffee*, *teff*, *wheat* and *maize*) are measured by the amount of harvested output in *kilograms* and their respective prices are in *Birr* per kilograms. Quantity and prices of *teff*, *wheat* and *maize* is aggregated and a simple average is calculated to obtain quantity and price of *food crops*. The sign of direct (own) price elasticity of these outputs, is expected to be positive. Particularly, the direct price elasticities of *chat* and *coffee* are expected to be positive. This is in consistent with the usual view that the supply of cash crops, in contrast with food crops, is more responsive to price changes (Abebe, 1998; Luelseged and Dercon, 1994).

*Coffee* is included in the system to represent the impact of other non-cash crops. A negative sign of cross- price elasticity,  $E(q_i / p_j)$  of *chat* with respect to *coffee* is expected which indicates farmers are reallocating resources into the production of *chat* in response to price increases.

In addition to *coffee* we included the price of major food crops (*teff*, *wheat*, and *maize*) to represent the impact of competitive food crops. We hypothesized *chat* competes with these and other food crops for the *scarce* inputs that are available to farmers. These three crops are selected as *major* food crops because they are the most important grains in terms of consumption and constitute roughly two-thirds of caloric intake in Ethiopia (Central

Statistical Authority, 2003/04). Moreover, the data set we used for estimation also shows that these there crops constitute about 65% of the total grains produced in the survey year. A typical alternative food crop, particularly, in South of Ethiopia, is *enset* (false banana). However we didn't include it as a competing crop, since as a cash crop it has limitations. The market for it is confined to specific groups and areas. We expect that the cross-price elasticity of the *major* food crops with respect to the price of chat to be negative. This implies that as the price of chat increases the production/supply of these crops declines. Similarly, the cross price elasticity of chat with respect to the price of food crops is expected to negative.

*Labor* is incorporated as one of the major inputs. It is considered a variable input in the model since we assumed it can be easily traded among farmers. It is defined as the number of person-days used in ploughing and harvesting. The wage-rate per person is calculated from the wage bill of hired labor. Labor used in weeding is also given in the data, but we have not included it for we assumed that it is not traded (i.e. weeding is carried out by women and children who rarely participate in off-farm employment). We expect a negative sign of the own-price (wages) elasticity of demand for labor. As wages increases farmers opportunity costs on-farm work increases so they are willing to work off-farm by hiring their labor. The cross-price elasticity of labor with respect to the price of crops is expected to be positive. The assumption here is that, as the price of a crop[s] increases in order to maximize profit farmers increase person-days [labor] used in harvesting that crop[s].

The second variable input considered in our model is *fertilizer-use (daps & urea)*. The house holds in the data set also used local fertilizers such as manure, but we have not included them. This is mainly because such types of fertilizers are not tradable as there are no *markets* where farmers can buy or sell them. Quantity of fertilizer- use is measured in amount of kilograms applied for each crop under review and the price is Birr *per kilogram*. The expectation is negative own-price elasticity for quantity demand of fertilizer- use, because as cost [input price) increases optimizing farmers reduces demand for that input and vice-versa. Moreover, similar to labor input, the cross-price elasticity of fertilizer-use input with respect to, particularly, the price of food crop[s] is expected to be positive. Whereas, negligible cross-price elasticity of fertilizer-use input with respect to the price of chat is expected as farmers of khat rarely use fertilizers, especially Urea and Dap.

*Land* and animal power are considered as fixed inputs in our model. In Ethiopia land is owned by the government (see The Constitution of the Federal Democratic Republic of Ethiopia, 1995); hence, farmers can not sell it or buy it in the market. Moreover these two inputs are usually considered as fixed since full adjustment to the desired allocation is *not* possible in the *short- run* (Sadoulet and de Janvry, 1995). For our estimation purpose *land* is measured as harvested acreage of crops (in hectares). Animal power is measured by the number of animals (cattle) owned and used in agricultural activities. We expect a positive relationship between each of these two fixed inputs (land and animal power) and the quantity of crop[s] produced. In other words, as the quantity of these inputs increases farmer's output supply also increases and vice-versa. However, insignificant relationship

is expected between animal power and production of chat, as farmers of chat do not use animals, especially for ploughing and harvesting.

Other factors which are not explicitly considered in this analysis, such as rainfall, access to credit etc. are incorporated in the constant term. This doesn't mean, however, that they are not important factors. For instance, if we take rainfall in the Ethiopian context, it has been a major factor affecting the agricultural sector of the country as whole and food production in particular. The only reason we didn't include these factors explicitly in this study is that: first, because they are not observable clearly in the data set; second, we assumed that such factors are purely exogenous and do not affect farmer's optimal choice, particularly, in the short-run.

Table 6 presents the basic quantity of output, quantity of input and price statistics for the households used in this study.

**Table 6 Summary of Descriptive Statistics on quantity of Output, Input and Prices**

	Mean	standard deviation
Quantity of chat (kg)	62.92	74.85
Quantity of coffee (kg)	111.56	119.00
Quantity of food crops(teff, wheat and maize) (kg)	594.60	419.31
Quantity of fertilizers(kg)	30.98	19.46
Labor(person days)	27.27	10.66
Price of chat (Birr/kg)	4.07	3.73
Price of coffee (Birr/kg)	2.94	5.04
Price of food crops(teff, wheat &maize) (Birr/kg)	1.64	0.23
Price of fertilizers (Birr/kg)	3.02	2.70
Wage rate	5.57	3.09
Land (hectares)	1.47	0.97
Animal Power (numbers)	3.66	2.57

**Source:** Ethiopian Rural Household Survey (Round five), 1999.

### 4.3. Estimation procedure

We have discussed in the previous chapter that, any *Profit function* that satisfies the restrictions imposed by theory (namely, linear homogeneity in prices, increasing in output prices, decreasing in input prices and increasing in fixed inputs) can be used to study the production behavior of firms (Varian et al, 1992). In empirical research the two widely used flexible functions to derive systems of output supply and input demand are the *normalized quadratic* and the *normalized Translog* profit functions (Abrar, 2001).

These functions are obtained by expanding any general profit function,  $\pi(p)$  in a second – order *Taylor series* at some arbitrary point  $p_0$  (a mathematical detail of this functional form is presented in Annex 1). This allows one to choose a function as an approximation to any more complex function (Chiang, 1985; Green, 2000). These functional forms has been widely used in the literature to obtain a coherent set of product supply and input demand relationships in various developing countries (e.g., Abrar, 2001; Shumay, 1983; Walter et al, 1998).

The *normalized quadratic* profit function is given as follows (Abrara, 2001; Walter et al, 1998):

$$\pi^* = \pi / P_n = a_o + \sum_i a_i P_i^* + 1/2 \sum_{i,j} a_{ij} P_i^* P_j^* + \sum_{i,m} a_{im} P_i^* C_m, \dots \dots \dots (4.3.)$$

Where ,  $i, j = 1 \dots, n - 1$ , with ,  $a_{ij} = a_{ji}$

$p_i^*$  = is the vector of price of outputs (coffee, food crops) and inputs (fertilizers and labor) normalized by the price of khat,

$\pi^*$  = is the normalized profit by the price of chat,

$C_m$  = is quantity of fixed inputs (land and animal power)

The system of output supply and factor demand is then derived by application of Hotelling Lemma to the above function (3.1) and is written as follows (Sadoulet and de Janvry, 1995):

$$q_i = a_i + \sum_j a_{ij} p_j^* + \sum_m a_{im} c_m, \dots\dots\dots (4.4)$$

$$q_n = \Pi^* - \sum_i p_i^* q_i = a_o - 1/2 \sum_{i,j} a_{ij} p_i^* p_j^*, \dots\dots\dots (4.5.)$$

Where,  $q_i$  = represents positive values for products (coffee and food crops) and negative values for variable factors (fertilizers and labor),

$p_j^*$  = their prices relative to the price of chat,

$c_m$  = represents the fixed factors (land and animal power).

$q_n$  = supply for chat, whose price served as a numeraire

Thus the system of output supply and factor demand model is consists of equations (4.4) and (4.5). To obtain maximum efficiency, the profit function (4.3.), the system of output supply and factor demand model (4.4and 4.5) are jointly estimated (Abrar, 2001). Estimation is done using Seemingly Unrelated Regression (SUR) method. SUR is preferred because this method estimates the parameters of the system accounting for heteroskedasticity and contemporaneous correlation across equations. Moreover, it allows for cross-equation restrictions on parameters (Green, 2000; Walter et al, 1998).

Finally, using the average (mean) value observed in the sample the own- price, cross-price elasticities of supply of products and factor demand is calculated as follows (Sadoulet and de Janvry, 1995):

$$\begin{aligned}
E(q_i / p_j) &= (a_{ij} p_i^*) / q_i \\
E(q_i / w) &= -[\sum_j a_{ij} p_j / w] / q_i = -\sum_j E(q_i / p_j), \text{ and} \\
E(q_i / c_m) &= a_{ik} c_m / q_i.
\end{aligned}
\tag{4.6}$$

The estimation is done using E-views software. The results of the econometric exercise are discussed in the next section.

#### 4.4. Estimation Results

We derived the system (equations) of output supply and input demand from the normalized quadratic profit function and this is presented in table 7.

**Table 7 estimated system of out put supply and input demand from the normalized quadratic profit function (N.B values for parameters are presented in table 8)**

$Q_{fc} = a_2 + a_8 * p_{fc} / p_k + a_{14} * PC/PK + a_{15} * W/PK + a_{16} * PF/PK + a_{20} * LAND + a_{21} * Z$
$QC = a_3 + a_9 * PC/PK + a_{14} * p_{fc} / p_k + a_{17} * W/PK + a_{18} * PF/PK + a_{22} * LAND + a_{23} * Z$
$L = a_4 + a_{10} * W/PK + a_{15} * p_{fc} / p_k + a_{17} * PC/PK + a_{19} * PF/PK + a_{24} * LAND + a_{25} * Z$
$QF = a_5 + a_{11} * PF/PK + a_{12} * p_{fc} / p_k + a_{18} * PC/PK + a_{19} * W/PK + a_{26} * LAND + a_{27} * Z$
$ \begin{aligned} QK = & a_1 + a_6 (LAND) - a_7 (Z) - a_8 / 2 (p_{fc} / p_k)^2 - a_9 / 2 (p_c / p_k)^2 - a_{10} / 2 (w / p_k)^2 + \\ & a_{11} / 2 (p_f / p_k)^2 + a_{12} / 2 (LAND)^2 - a_{13} / 2 (*Z)^2 + a_{14} (p_{fc} / p_k) (p_c / p_k) + a_{15} (p_{fc} / p_k) (w / p_k) + a_{16} \\ & (p_{fc} / p_k) (p_f / p_k) - a_{17} (p_c / p_k) (w / p_k) + a_{18} (p_c / p_k) (p_f / p_k) - a_{19} (w / p_k) (p_f / p_k) + \\ & a_{28} (*LAND)(*Z) \end{aligned} $

**Where,**

$Q_{fc}$  : is the supply function for food crops (teff, wheat and maize) quantity demand,

QC : is the supply function for coffee,

L : the demand function for labor,

QF : the demand function for fertilizers (dap and urea),

QK : The supplies function for chat.

$p_{fc}$  : Price of food crops

$p_c$  : Price of coffee

w: wage

$p_f$  : Price of fertilizers

$p_k$  : Price of chat

Z : animal power

Estimation of the parameters of the model presented in table 8 is made, first, using ordinary least squares. We then tested for group-wise heteroskedasticity. Based on the ordinary least square (OLS) results, the Lagrange multiplier (LM) test equals 46.73. The critical value from the chi-squared distribution is 9.49; so on the basis of LM test we reject the null hypothesis of homoscedasticity.

For testing the hypothesis that there is no correlation across the equations, a likelihood ratio test ( $\lambda_{LR}$ ) is constructed using the OLS results. Based on the iterated full information maximum likelihood estimates,  $\lambda_{LR}$  is found to be 89.55. The critical value from the chi-squared table is 23.21, so we conclude that the disturbances of the equations are also correlated.

We proceed to re estimate the regression allowing for heteroskedasticity and correlation of the disturbances across the equations. Seemingly Unrelated Regression (SUR) method is used to estimate parameters of the system. To obtain maximum efficiency the profit function is also included in estimation. SUR is preferred, because this method estimates

the parameters of the system accounting for heteroskedasticity and contemporaneous correlation across equations. Moreover, it allows for cross-equation restrictions on parameters. Regression results obtained from SUR are presented in table 8.

In terms of the significant parameters (see table 9), the coefficients of the single term of the normalized food crops price ( $a_8$ ), coffee price ( $a_9$ ), all the coefficients of land ( $a_{20}, a_{22}, a_{26}$ ), except  $a_{24}$  and the coefficients of animal power ( $a_{21}$  and  $a_{25}$ ) are significant. The coefficients of the normalized wage ( $a_{10}$ ) and fertilizer price ( $a_{11}$ ) are significant.

Moreover, we checked if the normalized quadratic profit function is consistent with the theoretical restrictions, as discussed in the previous sections. Results (see table 8) show that the normalized quadratic is consistent with the theoretical restrictions. This is because: *first*, the normalized quadratic profit function (NQ) is increasing in output prices, as the first derivative with respect to the normalized prices of food crops and coffee are positive ( see for the positive sign of the coefficients,  $a_2$  and  $a_3$ ). In addition to this, the NQ function is convex in output price as the second derivative with respect to the normalized prices of food crops and coffee are positive ( see for the positive sign of the coefficients,  $a_8$  and  $a_9$ ). *Second*, the NQ function is decreasing in input (labor and fertilizer) prices because the first derivative ( $a_4$  and  $a_5$ ) is negative and convex, because the second derivative ( $a_{10}$  and  $a_{11}$ ) is positive. *Third*, it is increasing and concave in fixed inputs because both the first derivatives with respect to land and animal power ( $a_6$  and  $a_7$ ) are positive and the second derivative ( $a_{12}$  and  $a_{13}$ ) negative.

<b>Table 8- Normalized Quadratic Function(NQ) Estimation</b>			
<b>Estimation Method: Seemingly Unrelated Regression</b>			
<b>Parameters</b>	<b>Coefficients</b>	<b>Std. Error</b>	<b>t-Statistic</b>
a <sup>1</sup>	76.66	54.94855	1.395177
a <sup>2</sup>	2.78	1.32479	**2.10005
a <sup>3</sup>	5.53	2.5000	**2.21960
a <sup>4</sup>	-14.90	5.039199	**2.957655
a <sup>5</sup>	-31.23	9.639707	*-3.240211
a <sup>6</sup>	86.09	47.56353	1.81000
a <sup>7</sup>	1.49	0.87880	1.670
a <sup>8</sup>	102.06	512272	**1.9923
a <sup>9</sup>	6.61	3.147619	*2.1000
a <sup>10</sup>	0.15	0.710845	***1.8042
a <sup>11</sup>	1.24	2.302389	**2.295
a <sup>12</sup>	-10.64	5.398519	-1.970000
a <sup>13</sup>	-0.58	0.275801	-2.10000
a <sup>14</sup>	-5.05	18.12098	-0.278637
a <sup>15</sup>	-3.62	4.641189	-0.780917
a <sup>16</sup>	-7.91	10.74650	-0.735852
a <sup>17</sup>	0.60	1.554010	0.389286
a <sup>18</sup>	-0.40	2.613489	-0.154716
a <sup>19</sup>	0.75	0.769958	0.973699
a <sup>20</sup>	10.45	80.76048	**1.9900
a <sup>21</sup>	132.62	22.62031	*5.862739
a <sup>22</sup>	23.94	23.87087	*2.1001
a <sup>23</sup>	9.75	7.576690	1.286584
a <sup>24</sup>	1.03	3.074267	0.334122
a <sup>25</sup>	1.19	0.787908	**2.331
a <sup>26</sup>	6.12	4.590319	**1.9700
a <sup>27</sup>	0.012	1.665426	0.007465
a <sup>28</sup>	-13.80	8.251862	-1.672886
R <sup>2</sup> = 69,			

\*Significant at 1%, \*\*Significant at 5% and \*\*\*significant at 10%

#### 4.5. Elasticities and policy implications

The elasticities estimated at mean values of prices and quantities are presented in table 9 and are discussed below:

Elasticity with respect to	Elasticities of output supply and input demand				
	food crops	coffee	chat	labor	fertilizers
<b>Crop prices:</b>					
food crops (teff, wheat, maize)	0.07	-0.03	-0.58	-0.05	-0.10
coffee	-0.01	0.04	-0.01	0.02	-0.01
chat	-0.05	0.07	-0.53	0.74	-0.11
<b>Factor prices</b>					
Wages	-0.01	0.01	0.01	0.75	0.03
fertilizer	-0.01	-0.002	0.05	0.02	-0.03
<b>Fixed factors</b>					
Land (area cultivated)	0.03	0.32	2.30	0.06	0.29
animal power (in numbers)	0.82	0.32	0.19	0.16	0.01

##### a. Elasticities of output (food crops, chat and coffee) Supply

The own price elasticity of food crops (0.07) has the expected sign, although it is low. The result indicates (although mildly) that farmers are price responsive. This is consistent with the usual view that the supply of a *subsistence* crop[s] with a relatively small market surplus is not that much responsive. The own price elasticity of both chat and coffee is -0.53 and 0.04 respectively. Although the own price elasticity of coffee is very low it has the expected sign; whereas, the supply elasticity of chat with respect to its price has the wrong sign. The latter result could be due to: (i) even if the price of chat decreases farmers

still respond by increasing their supply so as to satisfy their revenue *target*, (ii) as chat is a perennial crop and ones farmers invest in it they could not respond immediately by shifting away their resources, (iii) ones chat starts to give harvest its volumes steadily increase over all 8 -10 years period and even cannot be stored since it is a perishable crop, thus even if its price declines farmers would still supply more .

The supply elasticity of food crops with respect to coffee and chat price is -0.01 and -0.05 respectively. On the other hand, the supply elasticity of chat with respect to the price of food crops and coffee is -0.58 and -0.01. These results indicate that there is a substitution effect between food crops and cash crops (chat & coffee) and vice versa, i.e. between chat and food crops. Thus farmers who were producing food crops and coffee are shifting their resources in to the production of chat. Furthermore, there is no evidence that output of coffee would increase relatively higher than the reduction in the price of food crops. This can be seen from the low level of supply elasticity of coffee with respect to the price of food (-0.03).

The responsiveness of output of food crops with respect to both wages and fertilizer price (-0.01) has the expected sign, although it is negligible. Abrar (2001) has also found similar result of -0.002. The insignificance of food crops elasticity with respect to the price of fertilizer could be due to the inability of farmers to acquire fertilizer credits at the right time or at competitive prices. The low level of productivity of labor is evident from the low elasticity of food crops with respect to wage rate. Finally, we can see from the estimation result that output of food crops responds to animal power (0.82); relatively higher than with respect to area of cultivated land (0.03). The high supply elasticity of

food crops with respect to animal power (measured as number of cattle) is as expected, as cattle in rural Ethiopia are major means of ploughing, harvesting and transporting marketable outputs.

The responsiveness of chat supply with respect to land is found to be high (2.30) and low with respect to animal power (0.19). The latter could be due to low level use of animals in the production of chat. The elasticity of khat supply with respect to wage rate, which is 0.01, has a *wrong* sign. The expectation is a negative sign, which implies, for instance as the wage rate decreases supply of chat increases. The unexpected result could be, therefore, due to the fact that ones chat is planted it requires a minimal amount of labor input for harvesting and usually this is done by child and women labor, which are not usually traded. Finally, coffee supply is more responsive to non-price factors (land and animal power, with 0.32 elasticity for each), in contrast to wage rate and fertilizer price.

#### **b. Elasticities of Input (Labor and Fertilizer) Demand**

Labor has the wrong sign of own price elasticity (0.75). Demand of labor is more responsive with respect to, particularly, chat price (0.74). This result indicates that farmers reallocate their labor resource into the production of chat as the price of the latter increases. On the other hand, demand for labor is not that much responsive to the increase in the price of coffee, although it is more than with respect to the price of food crops.

Own price elasticity of fertilizer (-0.03) is low, suggesting that fertilizer prices would have to decrease substantially to increase the low level of fertilizer use in rural Ethiopia. Fertilizer demand is not also responsive to crop prices (-0.10, -0.01, -0.11) and has wrong signs; contrary to the usual view that the quantity demand of inputs increase as output price decreases and vice versa. The reason for the inelastic demand of fertilizer use with respect to the price of chat and coffee, could be that farmers rarely use fertilizers (urea and dap) in the production of coffee and chat. The data used for the estimation purpose also confirms this. The negative sign of the elasticity of demand of fertilizer-use with respect to the price food crops on one hand, and the expected sign of own price elasticity of fertilizer demand (-0.03) on the other suggests that more favorable fertilizer price would be more effective in encouraging increased use of fertilizer than would increase in output prices. Thus the appropriate policy focus is on input markets rather than output prices. Finally, fertilizer demand appears more responsive to land (area cultivated). This result indicates that land is not a severe a constraint for fertilizer demand as it is, for instance, for labor (0.29 and 0.06 respectively).

In sum, the above results indicate that: *first*, one of the reasons, for farmers to reallocate their resources away from the production of food crops and in to the production of chat is, in response to the decrease in the price of food crops. In other words, it is not due to the increase in the price of chat that farmers are producing more of chat and less of food crops (and coffee); rather it is due to the *un-competitive* price of food and coffee price. The *un-competitive* price of food crops could be either due to usual view that income elasticity of

food crops is usually very low or food-aid from abroad has been competing more with food crops than chat. This suggests that in order to encourage farmers to increase supply of food crops [which is the objective of the government] more favorable food crops prices would be effective. The appropriate policy focus is thus on food crops markets rather than chat markets. *Second*, results indicate that output of food crops (teff, maize and wheat) is more responsive to non-price factors. Particularly, the most important fixed input (land vis-à-vis animal power) in terms of output of food crops response is animal power. Therefore, the policy implication is that in order to encourage farmers to produce more of food crops, price policies should be accompanied with non-price policies.

## Chapter V Summary and Conclusions

The present study has two broad objectives. The first objective is to describe the role of chat in the Ethiopian economy. Data used for this purpose was obtained from various sources, such as the National Bank of Ethiopia, Ethiopian Rural Household Survey, Ethiopian Central Statistics Authority and Oromia Finance and Development Bureau. Primary data obtained by informal interviews were also used. Thus, using graphs and tables we described the economic contribution of chat at macro level, i.e. as a source of foreign exchange supply, tax revenue and employment.

Results indicate that area under chat cultivation which was 96,066 hectare in 2001/02 has increased to 111,578 hectare or increased by 16.15 percent in 2003/04. Chat production has also increased from 796,520 quintals in 2001/02 to 933,398 quintals or by 17.18percent in 2003/04. The export share of chat was about 16%,20%,19%,18%,21% and 25% in 1998/99, 1999/00, 2000/01, 2001,02, 2002/03 and 2003/04 respectively. This share is next to coffee, which its share was 75%, 70%, 57%, 60%, 60% and 63% respectively for similar periods. Moreover, tax revenue from chat for the Oromia region reached a higher amount of Birr 147 million or 28.8% of the total tax revenue in 1996E.C. Finally, the chat sector is found to a good source of employment (income) both for the farmers and urban dwellers.

The second objective of this study is to estimate the factors (parameters), both economic and non-economic, that affect the decision of chat producers; measuring its own-price supply elasticity; estimating its cross-price elasticities so as to examine its relationship

with other food and coffee. The study has presented results based on a profit-function analysis, an approach firmly rooted in neoclassical production theory. A multiple equation regression analysis is employed to derive system of output supply and input demand from a normalized quadratic profit function. Secondary data collected in 1999 by the Ethiopian Rural Household Survey is used. Regression results are used to estimate elasticities of output supply and input demand. Results obtained and their policy implications are summarized in the following paragraphs.

The supply elasticity of food crops (teff, maize & wheat) with respect to both coffee and chat price is -0.01 and -0.05 respectively. The result implies that, although it is low, farmers respond by decreasing supply of food crops as the price of coffee or chat increases. On the other hand, the supply elasticity of chat with respect to the price of food crops and coffee is -0.58 and -0.01. Estimation results indicate that the own price elasticity of food crops (0.07), although it has the expected sign, is low. The own price elasticity of both chat and coffee is -0.53 and 0.04 respectively. Although the own price elasticity of coffee is low it has the expected sign; whereas, the own price elasticity of chat has the wrong sign.

Based on these results it can be concluded that farmers are reallocating their resources in to the production chat not in response to the increase in the price of chat. Rather, they shift away from the production of food crops and coffee into the production of chat when the prices of the former decreases. In order to encourage farmers not to invest in chat production more favorable food crops prices would be more effective. Therefore, the appropriate policy focus is on output (food crops) markets rather than chat markets.

The responsiveness of output of food crops with respect to both wages and fertilizer price (-0.01), is negligible, although it has the expected sign. Results also indicate that output of food crops responds more to non-price factors. The most important non-price factor is animal power.

Thus, the policy implication is that in order to induce farmers to produce more of food crops (and less of chat) price policies alone could not bring the desired outcome. Rather, price policies should be accompanied by non-price policies.

Finally, *chat* is clearly an important cash crop in Ethiopia, well-known for its foreign currency earnings. Nonetheless, it is little understood and given no development and research attention. Millions of people both in Ethiopia and other countries are making a living from the crop. Nevertheless, it is mostly viewed as a socially undesirable “drug plant”. Different governmental bodies have attempted to impose restrictions against the crop at different times considering it socially undesirable, apparently because the economic role of the crop is not well understood.

It is recommended that the economic benefits and costs of *chat* should then be considered against an understanding of the negative physical and social effects of *chat* use/abuse before considering possible strategies to assist *chat* growing communities through the substitution of alternative crops, such as coffee and or food crops. Only through a balanced analysis, taking into consideration all factors (economic, social, cultural and environmental), the cultivation and use of *chat* can be understood in a proper context.

Therefore, further research is needed in order to improve the basis for making all rounded policy decision.

Furthermore, the model presented in this study represents an extreme simplification of the complex micro level decision framework, which ignores such important features as risk aversion, imperfect markets, incomplete information, dynamic adjustments, and sequential decision making. Another point of attention, particularly relevant for chat production, refers to the difficulty of modeling long-term response. Since chat is a perennial crop the most substantial production effect following a price increase is expected to take place only after a few years, when newly planted tress become productive. Further research, which considers these issues, is needed in order to improve the basis for making (long-term) policy decisions.

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## ANNEX (1)

### Taylor expansion

The *Taylor* expansion gives an approximation of a function  $f(x)$  at some arbitrary point  $x_0$ . It is written:

$$f(x) = f(x_0) + f'(x_0)(x-x_0) + f''(x_0)/2(x-x_0)^2 + \dots$$

The first-order approximation takes the first two terms and is a linear function:

$$f(x) = a + bx.$$

The second-order approximation, which takes the first three terms, is a second degree polynomial:  $f(x) = a + bx + cx^2$ . This allows one to consider the choice of a linear or quadratic function as an approximation to any more complex function.

A useful form of *Taylor* expansion uses the logarithmic transformation to arrive at elasticities rather than marginal changes.

## Declaration

I, the undersigned, declare that this thesis is my own work and has never been presented for a degree in any other university. All source of materials used for this study have been duly acknowledged.

Declared by:

Name: Michael Arrefaine

Signature: 

Date: June, 20, 2005

Place and date of submission: Addis Ababa, June, 2005.